POWER

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Atlantic City Pumping Plant

By Warren O. Rogers

SYNOPSIS—Fire destroyed the old nonfireproof pumping plant, but disabled the plant machinery only 19 hr. while repairs were being made. The present building is fireproof throughout. The pumps are of several designs, but the old units will ultimately be replaced by more modern pumping engines. Provision has been made in the pipe-line construction to prevent a possible disabling of all boiler or pumping units. Three sources of feeding the boiler have been provided.

Atlantic City, N. J., with an estimated resident population of 55,000, and during the summer months with an estimated population of from between 125,000 and 200,000 is confronted by a condition encountered by but few if any cities of similar size. Although the population during the winter is but one-fourth of that of summer, the pumping equipment of the city pumping plant must be of sufficient capacity to supply the demands the year round; hence the capacity of the pumping apparatus is necessarily greater than would be required under ordinary circumstances.

During the year of 1912 the average amount of water pumped per day was 9,774,200 or 3,567,583,000 gal. for the year. It is during the months of July and August that the maximum consumption occurs, which for one day was 14,057,000, and for one month was as high as 12,291,000 gal. per day. An approximate maximum rate for one day has been as high as 16,000,000 gal.; approximated because the maximum capacity of the meter was 14,000,000 gal. per day.

Prior to 1895 water was supplied to the city by two private water companies. Both systems, however, were purchased by the city and in 1904 all water was supplied from the Absecon pumping station. This plant was destroyed by the fire in the latter part of 1909, and the new

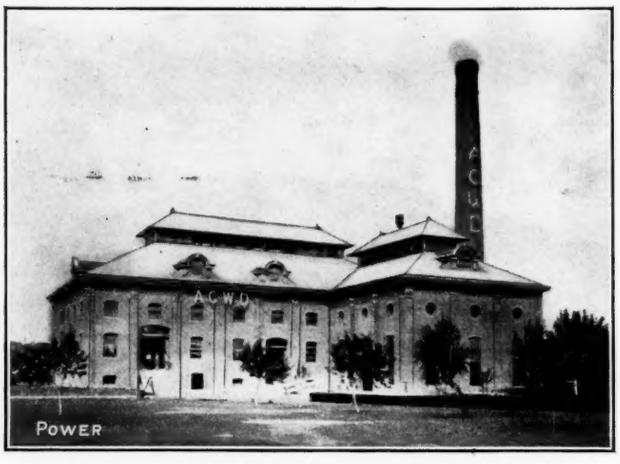


Fig. 1. Atlantic City Pumping Plant

plant was erected on the site of the old, and was completed in 1911. The old building was of wood, brick walls, wood floors and roof, and, although completely destroyed, the machinery was damaged but slightly. In fact, due to the efforts put forth by the engineers, the system was out of service but 19 hr., while the débris was being cleared away and necessary repairs to pipe lines, etc., were being made. The boiler and pumping units were protected by a temporary shelter while the new building was being built.

In Fig. 1 is a view of the new fireproof building. It

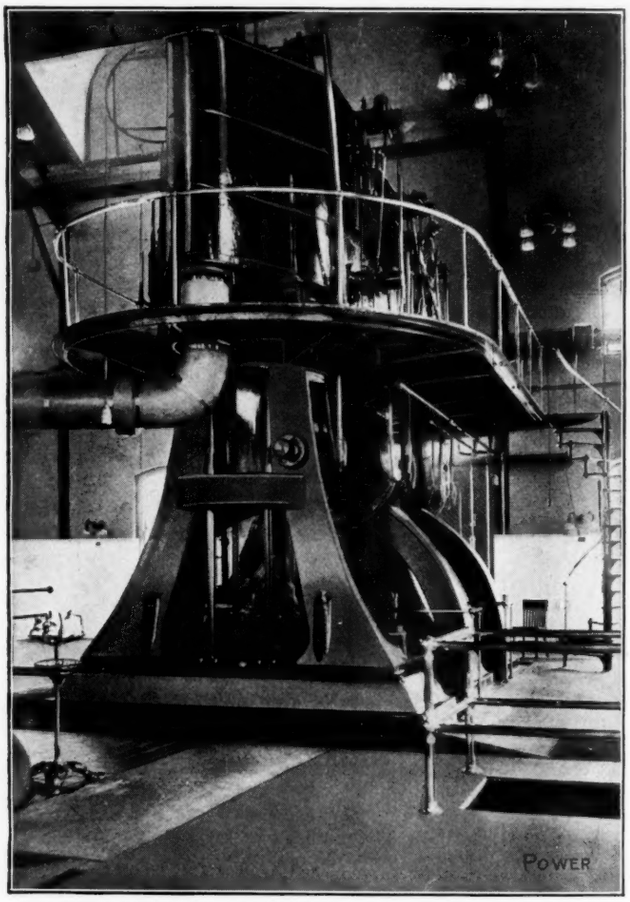


Fig. 2. The 12,000,000-Gal. Triple-Expansion Pumping Engine

is of red brick; the inside is finished with a white-enameled wainscoting of such a height that when the floors, which at present are on two levels, are made the same the finish of the walls will be uniform; the upper walls are painted cream color. The upper floor is finished in red tile; the lower floor is of concrete. The building is 70x80 ft. with a reinforced-concrete roof supported by steel trusses.

Upon the upper floor of the pump room, which is 40 by 70 ft. in dimension and is 6 ft. above the lower floor, contains one vertical, triple-expansion, condensing, crank and flywheel, triple, single-acting pumping engine. The steam cylinders are 19½, 36 and 52 by 36 in. with water plungers 24¾ in. in diameter. The pump, Fig. 2, runs at 38 r.p.m., and has a capacity of 12,000,000 gal. per day. The water cylinders are in the basement, which is separated from the lower floor level by a concrete wall. On the same floor level is a 10,000,000-gal., turbine-

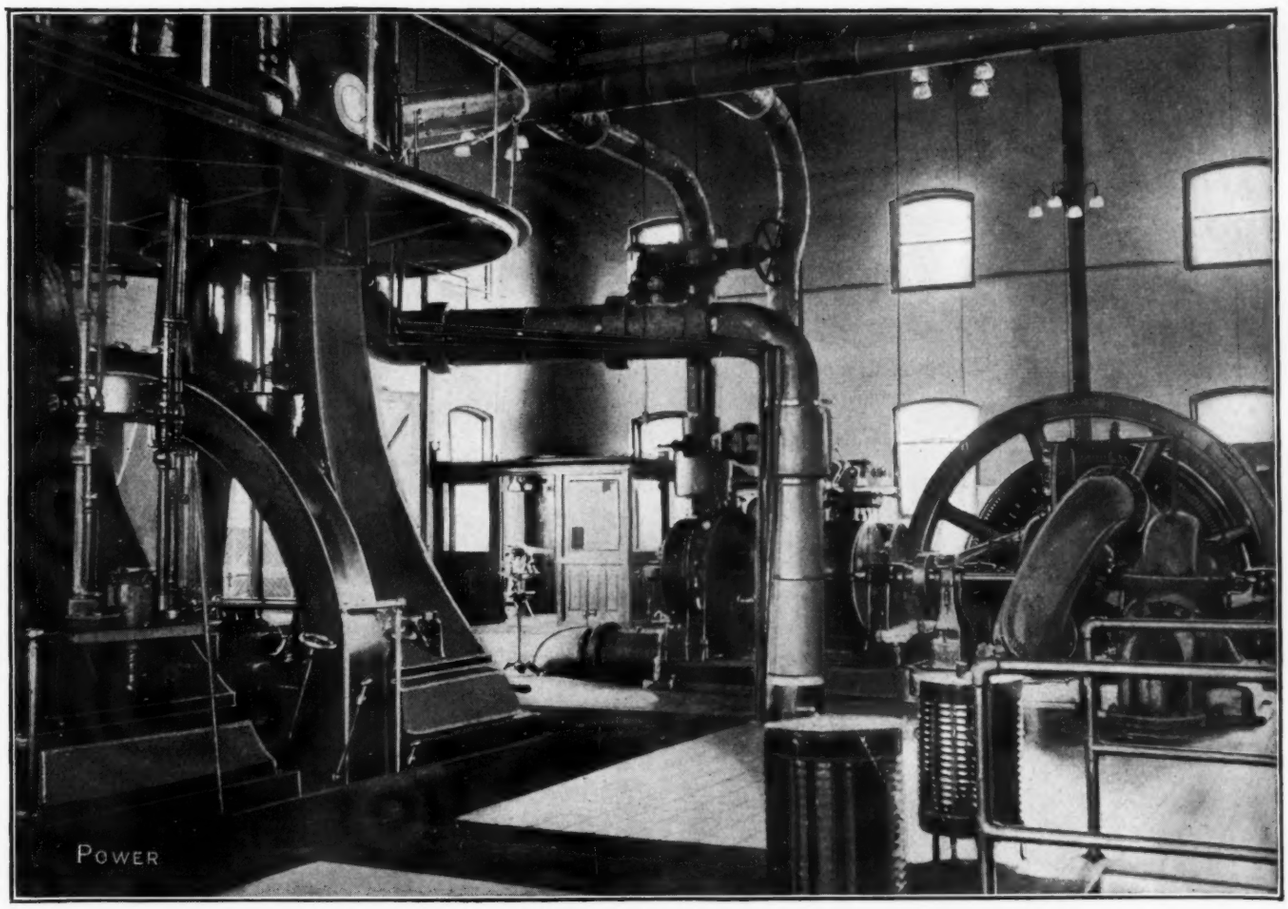


FIG. 3. PARTIAL VIEW OF THE UPPER FLOOR, WITH VERTICAL PUMP IN THE FOREGROUND, TURBINE-DRIVEN CENTRIFUGAL PUMP AND ENGINE-DRIVEN GENERATOR AT THE RIGHT

driven, two-stage, centrifugal pump. This unit is shown in Fig. 3. The 300-hp. turbine drives the pump at 850 r.p.m.

In the basement, under the last mentioned units is a 40-hp. turbine-driven, single-stage centrifugal pump with a capacity of 5,000,000 gal. per day at 850 r.p.m. It has a lift of 25 ft. This unit pumps from the driven wells to the high-pressure pump reservoir.

On the lower floor are two horizontal, cross-compound condensing compressors with steam cylinders 10 and 16 and 11 and 18 in., air cylinders 14 and 16 in., and 12- and 14-in. stroke respectively. The air pressure is 25 lb. per sq.in., and the units have a rated capacity of 600 and 1000 cu.ft. of air per min. respectively. With the air compressors on the lower floor level are the three compound reciprocating pumps, Fig. 4. The largest of the reciprocating pumps has a capacity of 6,000,000 gal. per day at 18½ r.p.m. with cylinders 21, 40 and 21½ by 36 in. The next largest pump is of 3,500,000 gal. capacity, having cylinders 16, 24 and 18 by 18, running at 31 r.p.m. The smaller unit is of 3,000,000 gal. capacity and has cylinders 10, 18 and 12 by 16 in.; it runs at 59 r.p.m.

During the winter months water is pumped by the large flywheel pump, but in summer two of the three large pumps are in service to meet the increased demand for water.

BOILERS

The plant is divided into three parts, the pump room and two boiler rooms, which are at one end of the main

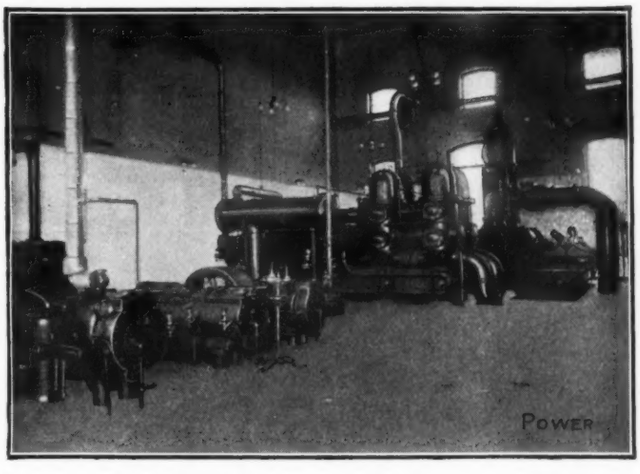


FIG. 4. AIR COMPRESSORS AND CONDENSING RECIPROCATING PUMPS

part of the building. The boiler room forms an ell portion of the plant, and contains six water-tube boilers. Two are of 125-hp., two of 200- and two of 300-hp. rating with 33, 49 and 51 sq.ft. of grate surface respectively. The 200-hp. units have 2000 sq.ft. of heating surface, the 300-hp. units, 2931 sq.ft. The pressure carried is 125 lb. The 125- and 200-hp. boilers are in the boiler room at the end of the pump room, Fig. 5, and the two 300-hp. boilers, Fig. 6, are in the ell portion with room for two more of similar capacity.

All boilers are set in batteries of two and are fed by duplex boiler-feed pumps of which there are two with 6 and 4 by 6-in. cylinders and one with 10 and 6 by 10-in. size. Two of these pumps are in No. 1; the larger one in No. 2 boiler room. Each pump rests on a concrete foundation 18 in. above the floor level. Two injectors

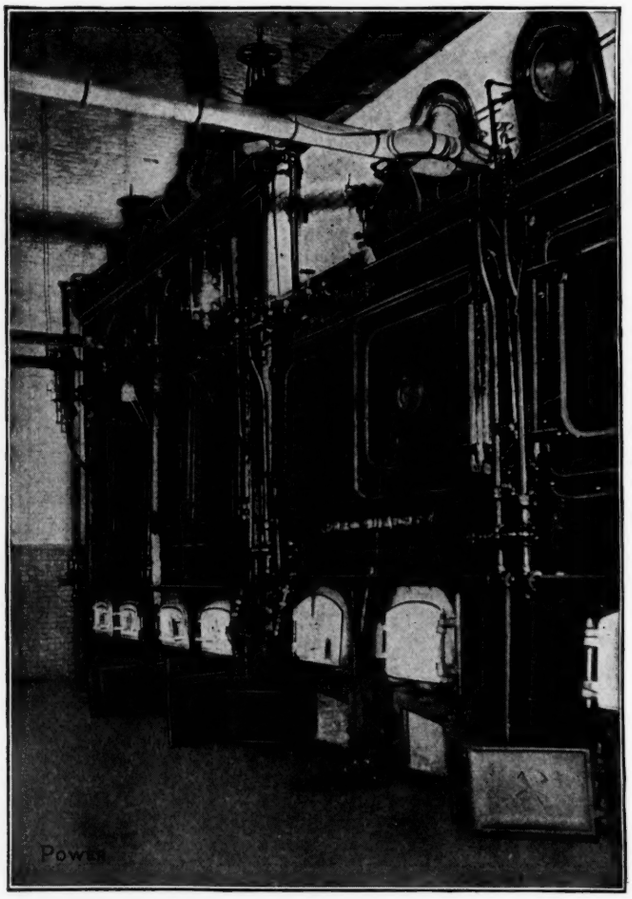


FIG. 5. FOUR OF THE SIX WATER-TUBE BOILERS

are also piped up to be used in emergencies if the pump should become inoperative.

All feed water is metered by either of two meters placed between the feed pumps and the 600-hp. open heater. The meters are arranged for bypassing in case repairs are necessary.

All doors communicating with the boiler room are single metal automatic fire-doors. At the rear of each battery of boilers is a set of large double doors opening to the outside of the building, which is exceedingly convenient in case it is necessary to remove old or install new boilers. Provision has also been made for an additional heater without change of piping by the removal of a flange on the 14-in. vertical, exhaust-steam pipe.

Bituminous coal is delivered to the plant by teams under contract from the railroad, 1½ miles distant. It is dumped into the hopper of a coal conveyor, which discharges it into a concrete coal pocket of 400 tons capacity. An industrial track runs from in front of the boilers to beneath a discharge opening in the bottom of the coal pocket, through which coal is discharged into 1-ton metal charging cars.

WATER SUPPLY

Water pumped by the station is obtained from twenty-one 10-in. wells, provided with 8-in. strainers and 6-in. suction pipes, and driven 100 and 200 ft. to different strata. One line of 10 wells is operated by an air lift, air being supplied by the two compressors already mentioned. The supply of water from this group is at least 2,000,000 gal. per day. A second group of wells is connected to the centrifugal pump installed in the basement under the electric-generating unit. The pump delivers at a low head into a flume leading to one of two receiving wells. The capacity of this group of wells is about 3,000,000 gal. of water per day.

At the end of the wooden conduit is a basin with sloping sides. It has a normal capacity of 700,000 gal. This basin is connected with the north pump well by a 300-ft. wooden flume. Midway of the flume a 20-in. cast-iron main runs to the artesian basin and a wooden flume to the south pump well. The basins act as an additional water supply to the normal water supplied by the wells.

Beside the wells there is a surface supply for a watershed 18 sq.in. in area. The maximum runoff of Absecon Creek is about 7,500,000 gal. per day. All water pumped is metered. The meter has a rate-flow dial, a daily chart and a register.

PIPING

In Fig. 7 is shown a general plan of the live and exhaust steam and water piping of the plant. Above the front end of the boilers in No. 1 boiler room is an 8-in. header to which the four boilers are connected by 5- and 7-in. lead pipes from the 125- and 200-hp. boilers respectively. These lead pipes are equipped with a stop and a nonreturn valve placed in the line close to the 8-in. header. The 300-hp. boilers are piped through nonreturn valves and stop valves in the 7-in. leads to a 10-in. header which runs along the wall separating the boiler and pump rooms. The 8- and 10-in. headers are tied together by a 4- and 6-in. pipe, each provided with stop valves so that any section of header connected to any particular battery of boilers can be cut out of service. In like manner the

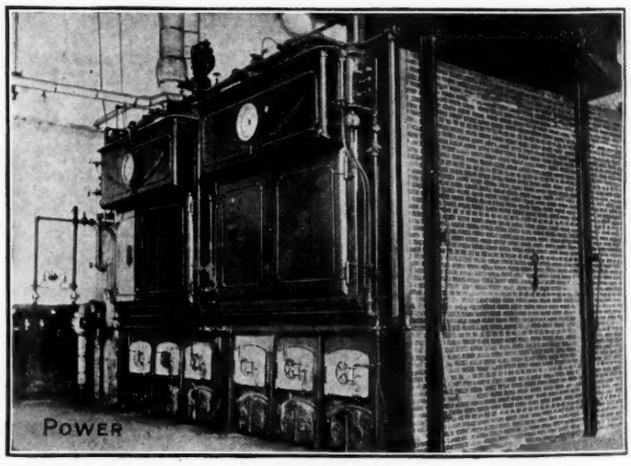


FIG. 6. TWO 200-HP. WATER-TUBE BOILERS

boilers and that part of the 10-in. header in No. 2 boiler rooms can be cut out of the line.

The 6-in. steam line in the pump room is of the loop design. It is connected to the 10-in. header, as indicated and runs to the far end of the pump room, returning about midway of the room, and connecting to the outer end of the 10-in. header. A 5-in. branch pipe supplies

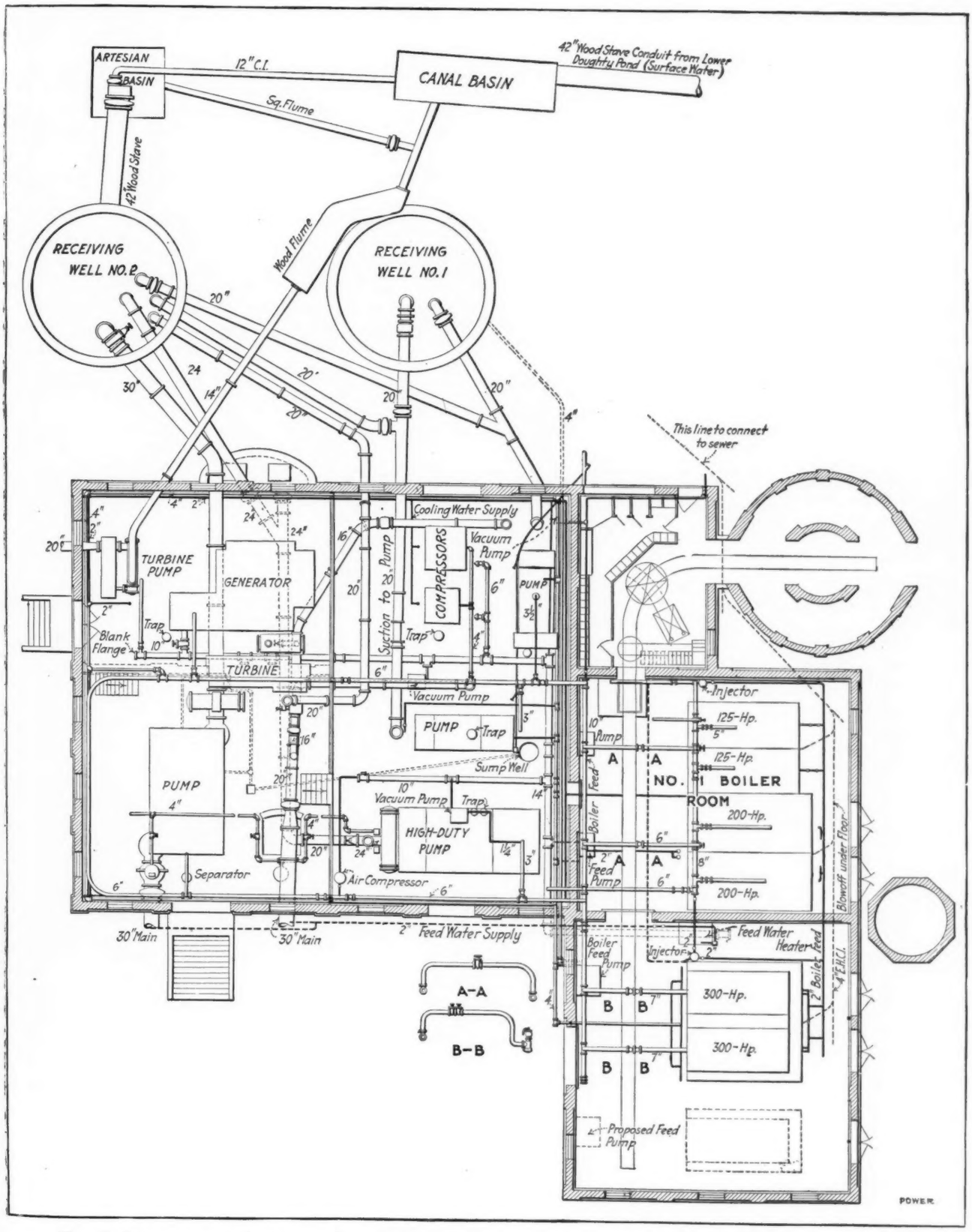


FIG. 7. PLAN OF THE ATLANTIC CITY PUMPING PLANT, SHOWING PIPING AND EQUIPMENT LAYOUT

the large duplex pump. The vertical pump is connected to the 6-in. main by a 4-in. pipe. And two 5-in. branch lines supply the turbine-driven pump and the generator engine. The two other duplex pumps are connected to 3- and 4-in. pipes. The branch to the compressors is of 4-in. diameter.

In the boiler room a 2-in. auxiliary pipe line is connected to the 10-in. header at each end, from the under side and is fitted with a valve in each connection so that the line can be cut off from the header at each end, thus giving the feed-pump header two sources of steam supply in case an accident happens to any part of the 10-in.

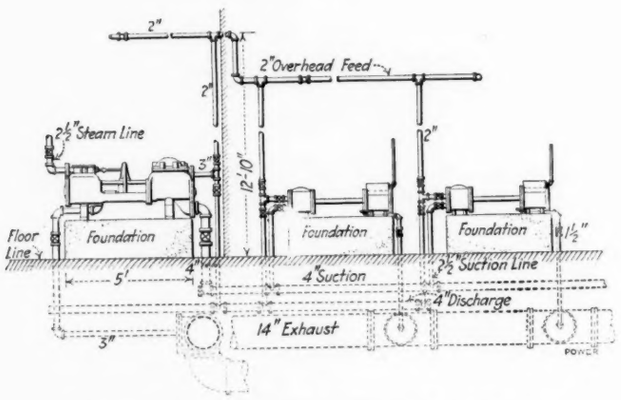


FIG. 8. PIPING OF THE BOILER-FEED PUMPS

header.* A 2-in. steam pipe drops from the auxiliary header to each boiler-feed pump.

The well centrifugal pump, generator engine and air compressors exhaust into a 10-in. pipe, which runs lengthwise and about through the center of the pump-room basement. This connects to a 14-in. header running across the boiler-room end of the pump-room basement to the feed-water heater in No. 2 boiler room. The exhaust from the boiler-feed pumps also discharges into the 14-in. exhaust line. The heater is connected with a 14-in. atmospheric exhaust line.

The piping of the boiler-feed pumps is shown in Fig. 8. Two sources of boiler feed are obtained from each pump; one through the 2-in. overhead line; the other through the 4-in. underground line to which each pump is connected by a 2-in. pipe for the smaller pumps and a 3-in. pipe from the larger pump. A third source of feed-water supply is by the two injectors, which discharge through a 2-in. line to the rear of the drum of the boilers. This system calls for two feed headers at the boilers, one above the firing door, the other in front of the steam drums and above the boiler fronts. These 2-in. headers are connected at the ends and so fitted with valves that various combinations can be made to maintain the boiler feed in case of accident to either of the feed lines.

The pump-room basement is encircled by two pipe lines. One is of 4 in. diameter and supplies water for priming the various pumps through branch lines. The other pipe line is provided with valves and connections for ¾-in. hose and supplies hot water for washing down the floors, etc. The waste water goes to a hotwell and is discharged to waste.

MISCELLANEOUS

Operation of the station is by two shifts of 11 and 13 hr. respectively. Metal lockers are provided for the men and hot and cold water in the wash room, where there is a shower bath and toilets.

At the end of the boiler house is a small machine shop for making light repairs. The machines are driven by a 7x7-in. vertical steam engine. A stock room contains metal bins for pipe fittings, etc. A first-aid cabinet, for possible injuries is placed where it is easily accessible.

The building is illuminated by 96 sixty-watt tungsten lamps, the fixtures being of verdi antique finish. Flush wall receptacles at various points for extension cords furnish convenient light for repair work about the pumps.

Contemplated improvements at the plant include the installation of a centrifugal pump to displace the air compressors and putting in two more 12,000,000-gal. pumps to replace the old reciprocating pumps, and to also provide sufficient pump capacity for the increasing demand on the station.

The writer is indebted to L. C. Manz, assistant engineer and superintendent, who designed the new pumping station, and to Harry Bacharach, Director of Parks and Public Property, in whom the supervision of the department is vested, for data contained herein.

L. Van Gilden is engineer and superintendent.

PRINCIPAL EQUIPMENT OF THE ATLANTIC CITY PUMPING PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Pump	Triple expansion	9½, 36 and 52 by 36"	Main pumping unit	Condensing, 125 lb. pressure, 38 r.p.m.	Bethlehem Steel Co.
1	Pump	Centrifugal 2-stage	10,000,000 gal.	Emergency fire unit	Turbine driven, 850 r.p.m.	De Laval Steam Turbine Co.
1	Turbine	De Laval		Drives 10,000,000 gal. centrifugal pump	Condensing, 125 lb. pressure, 850 r.p.m.	De Laval Steam Turbine Co.
1	Engine	Corliss	16x30"	Drives alternating generator	Condensing, 125 lb. pressure, 120 r.p.m.	Bates Machine Co.
1	Generator	Alternating current	150 kv.a.	Station lighting	Three-Phase, 60 cycles, 120 r.p.m.	Fort Wayne Electric Co.
1	Turbine			Drives low-lift centrifugal pump	Condensing, 125 lb. pressure, 850 r.p.m.	
1	Pump	Single stage, centrifugal	5,000,000 gal.	Pumps from wells	Turbine driven, 850 r.p.m.	Platt Iron Works
1	Compressor	Horizontal	10, 16 and 14 by 12"	Well air lift	600 gal. capacity, 12 r.p.m.	Ingersoll-Rand Co.
1	Compressor	Horizontal	11, 18 and 16 by 14"	Well air lift	1000 gal. capacity, 14 r.p.m.	Ingersoll-Rand Co.
1	Pump	Compound duplex	21, 40 and 21½ by 36"	Main pumping unit	Condensing, 18½ r.p.m.	Henry R. Worthington
1	Pump	Compound duplex	16, 24 and 18 by 18"	Main pumping unit	Condensing, 31 r.p.m.	Laidlaw-Dunn Gordon
1	Pump	Compound duplex	10, 18 and 12 by 18"	Main pumping unit	Condensing, 59 r.p.m.	Laidlaw-Dunn Gordon
2	Boilers	Water tube	125 hp.	Steam generators	Hand fired, 125 lb. pressure	National Boiler Works
2	Boilers	Water tube	150 hp.	Steam generators	Hand fired, 125 lb. pressure	E. Keeler Co.
2	Boilers	Water tube	200 hp.	Steam generators	Hand fired, 125 lb. pressure	Heine Safety Boiler Works
1	Pump	Duplex	10x6x10"	Boiler feed	Variable speed	Henry R. Worthington
2	Pumps	Duplex	6x4x6"	Boiler feed	Variable speed	Henry R. Worthington
2	Meters	Torrent			Continuous	Hersey Mfg. Co.
1	Heater	Open	600 hp.	Feed water	Exhaust steam	Harrison Safety Boiler Wks.
1	Chimney	Radial brick	125 ft. high, 6' 6" dia. top	Flue gas	Natural draft	Heine Chimney Co.
2	Injectors	Sellers		Spare boiler feed	High pressure	Wm. Sellers & Co.
1	Meter	Venturi	10½x30"	Station water output		Builders Iron Foundry Co.

*The steam connection to the two 6x4x6 pumps is 1 in. while the steam connection to the 10x6x10 pump is 2 in.

Task Setting for Firemen

Walter N. Polakov, in a paper presented under the above title, at the recent meeting of the American Society of Mechanical Engineers, describes an investigation made under his direction of the fire-room methods employed at the Warrior Ridge Station of the Penn. Central Light & Power Co., the methods adopted to improve the efficiency and the results obtained. He proceeds at first to determine the maximum efficiency of the plant under operating conditions, and then to provide that this efficiency shall be maintained, not during a few hours or days that the test is being run, but continually.

The well known fact that the high efficiency attained by experts during the boiler tests is seldom maintained in everyday practice is due to gross neglect on the part of the management to:

a. Record the conditions causing the high efficiency during the tests.

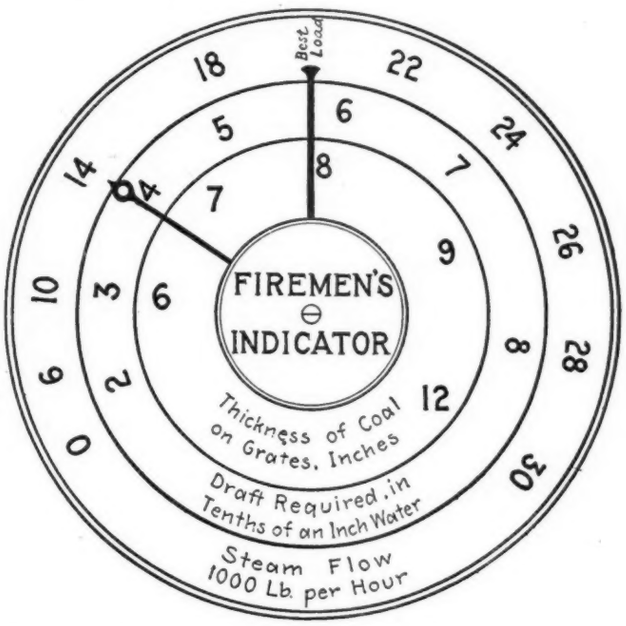


FIG. 1. DIAL OF STEAM-FLOW METER WITH SPECIAL SCALES FOR USE AS FIREMAN'S INDICATOR

b. Instruct the men how to regulate these conditions in order to duplicate the test results, and

c. To provide an incentive to the men for striving for the purpose desired by the management or owners.

A continuous test extending over 80 days, made to determine the results of the existing practice, indicated a combined efficiency of boiler and grate of 52.37 per cent. A 13-hr. test, during which a deliberate attempt was made to make a favorable showing under those conditions, resulted in an efficiency of 67.94 per cent. Analysis and improvement of these conditions raised this efficiency to 77.66 per cent., which was adopted as the practical maximum for this plant.

The next question was to ascertain what would be the reasonable limit below which no fireman should allow his efficiency to drop. In this connection the factors beyond the control of the fireman were to be considered, viz., sudden fluctuation of load and impracticability to analyze gases every few minutes, drop of attention every 40 min. for a period of 11 to 20 min., and the effect of cooling off heating surface and furnace walls during the cleaning of fires (the allotted time for this was set on time study as 18 min. per 100 sq.ft. of grate surface). On the other hand, there was made a correction for blowing off the boiler once in every 24 hr. which credited the boiler with so much metered water and debited it with so many heat units in the same amount of water at the boiler temperature. As a result of these investigations and studies it was found that the standard for the task should be set at 70 per cent. combined boiler and grate efficiency.

It is interesting to note that all the officials of the concern, and the representative of the boiler maker, considered the task on this basis too high, and that accomplishment of it would be out of the question. The only argument that obtained its temporary approval was that it was easier to reduce the task in the future, if not feasible to accomplish it, than to make it higher. The fourth month of the test work, however, proved that 73.1 per cent. of boiler and grate efficiency was permanently maintained, effecting for the company a gross saving of approximately 25 per cent. on the fuel bill alone. This was accomplished without heavy investment for improvement of equipment like automatic stokers, special grates, force-draft fans, soot blowers, etc. The only expense was for a few instruments for the guidance of the firemen in their work of living up to the instruction card.

As, with other conditions equal, the weight of steam is in direct proportion to the weight of fuel burned, the first instrument necessary for informing the firemen as to how much coal to put in the furnace, is a meter indicating the output of the boiler, but as this proportion is constant only at a given condition of combustion, the firemen have to be informed at all times as to what these conditions are. Since complete combustion requires a strictly defined quantity of air per pound of fuel of given composition, we have to know

a. Composition of fuel.

b. Rate of firing.

c. Rate of air supply.

In most cases it is possible to obtain fuel of practically uniform analysis, so that the first variable may be taken as a constant. The rate of firing is indicated by the steam-flow meter inasmuch as conditions of combustion are uniform. The last factor, then, the quantity of air to be supplied per minute to the furnace, is the factor which must be controlled.

This reasoning leads to the conclusion that for practical guidance the fireman needs at least three instruments:

a. Indicating steam meter.

b. Draft gage.

c. Indicator for the coördination of the condition of firing with the load carried by the boiler at any moment.

The author found the General Electric steam-flow meter of the indicating type satisfactorily to serve the third mentioned purpose. He arranged on the dial of the steam-flow meter an inside dial, as shown in Fig. 1, with numbers indicating the required thickness of fuel bed corresponding to the number of pounds of steam drawn

from the boiler, and a third dial with numbers indicating the draft which is necessary and sufficient to supply the required quantity of air for the combustion at a rate called for by the indicated steam demand. Thus if the pointer, as in Fig. 1, shows that steam is flowing from the boiler at a rate of, say, 14,000 lb. per hour, the fireman will know that the figure four under the pointer on the middle scale means that a draft of 0.4 in. of water is needed, and that the location of the pointer on the inner scale between the figures six and seven calls for a thickness of fires of from 6 to 7 in.

The next information vitally important for the fireman is the frequency with which his furnace must be coaled to keep the fire in best condition. The method adopted by the Italian Navy is accepted by the author as most satisfactory, consisting chiefly in bell signaling at intervals in proportion to the load carried by the boilers, which signaling is regulated by clock mechanism connected with a flow meter. For this purpose the counter of the feed-water weigher supplying water to the entire boiler house rings the bell every time a certain number of thousands of pounds of water is fed to the boilers, thus giving notice to the fireman that an adequate number of shovelfuls must be thrown into each furnace. This number is easily determined, since the weight of a shovelful of coal is known, and the rate of apparent evaporation at the given condition of firing is a constant.

Consideration is then given to the calculation of the different efficiencies.

Various schemes have been used as the basis of task setting for firemen, which, to the author's knowledge, have always created dissatisfaction. Certain of these are as follows:

A. The cost of steam generated was used for the basis of the task in the boiler room of a large cement plant, and a premium offered for the reduction of this cost, but as the firemen have no control over the purchase of fuel, maintenance of equipment, etc., as this task involves the standardizing of conditions of combustion for which no instruments were provided, and as no definite standard or aim was set before them, the scheme was soon abandoned.

B. A high percentage of CO_2 in the flue gas was adopted as a task basis for firemen in several plants, but the men were not trained, nor were they even shown how to obtain it. When they occasionally attained the mark, the question remained undecided whether high percentage of carbon dioxide was coincident with the most economical steam generation or not, and the method proved generally unsatisfactory.

C. A high percentage of CO_2 and low percentage of combustible in the ashes were factors upon which another attempt was made to specify more definitely the fireman's task. The question remains, however, whether the conditions which the fireman must observe to attain the task and produce gas rich in carbon dioxide, and an ash with little carbon, are actually the best for transmitting the heat of the gases to the water and steam, and whether at any load the same standard is equally beneficial.

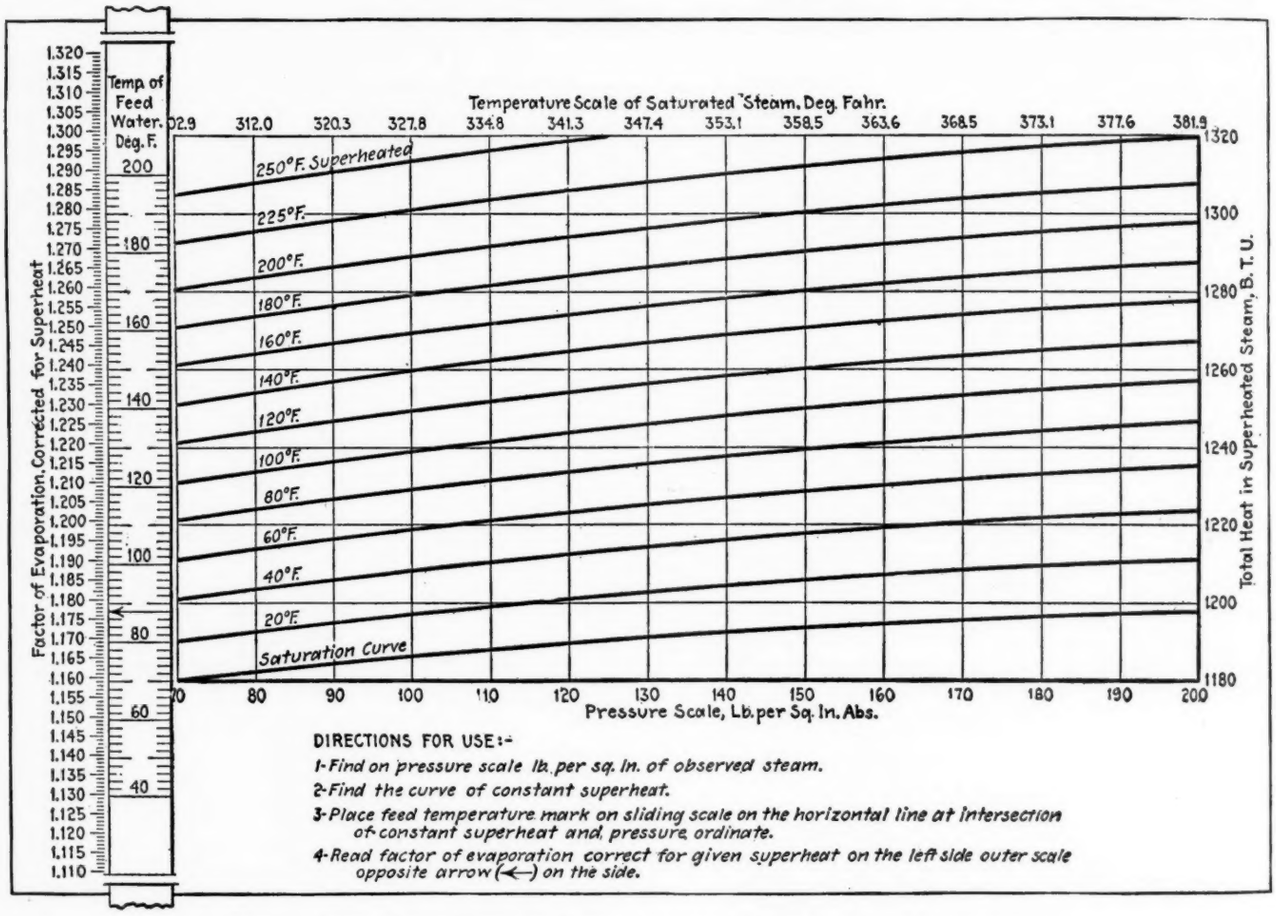

Temp of Feed Water. Deg. F.
Temperature Scale of Saturated Steam, Deg. Fahr.
302.9 312.0 320.3 327.8 334.8 341.3 347.4 353.1 358.5 363.6 368.5 373.1 377.6 381.9
250°F. Superheated
225°F.
200°F.
180°F.
160°F.
140°F.
120°F.
100°F.
80°F.
60°F.
40°F.
20°F.
Saturation Curve
Factor of Evaporation, Corrected for Superheat
Total Heat in Superheated Steam, B. T. U.
Pressure Scale, Lb. per Sq. In. Abs.
DIRECTIONS FOR USE:-
1- Find on pressure scale lb. per sq. in. of observed steam.
2- Find the curve of constant superheat.
3- Place feed temperature mark on sliding scale on the horizontal line at intersection of constant superheat and pressure ordinate.
4- Read factor of evaporation correct for given superheat on the left side outer scale opposite arrow (←) on the side.

FIG. 2. SLIDE RULE USED FOR DETERMINATION OF FACTORS OF CORRECTION

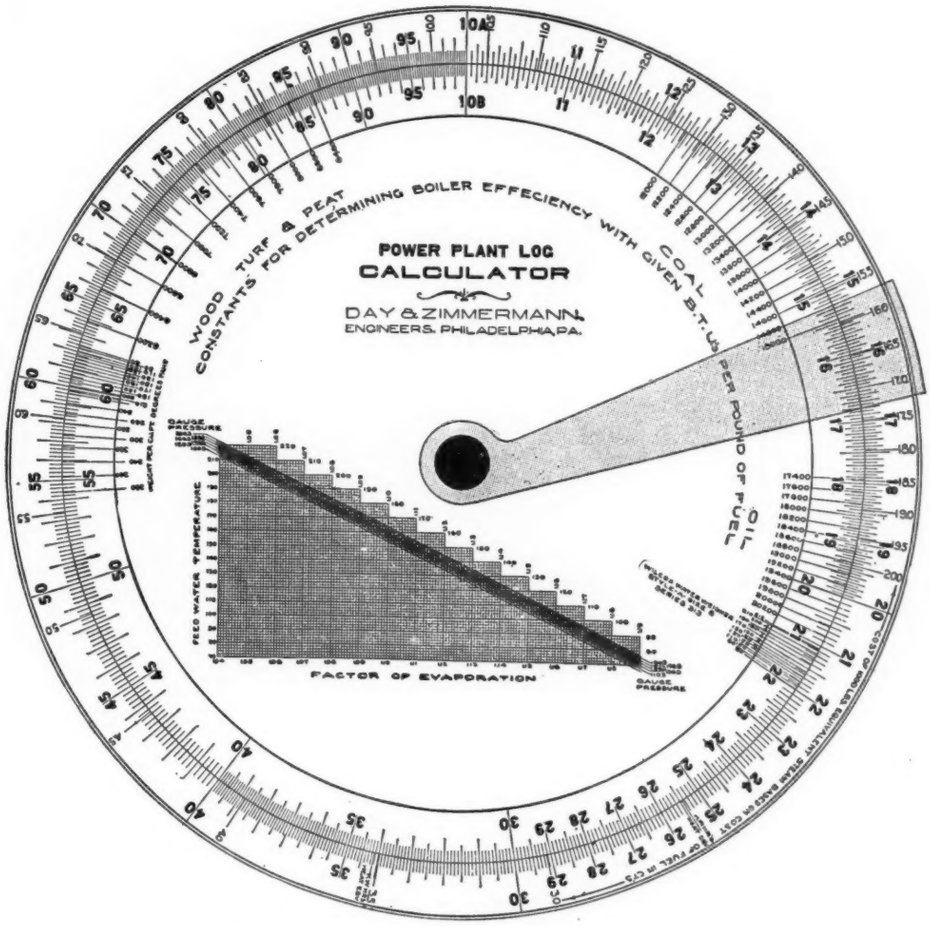


FIG. 3. POWER-PLANT LOG CALCULATOR

D. A limit on coal consumption as a task for railroad firemen was favored at one time. This idea, probably the most ridiculous and illogical, soon demonstrated its own weakness, and has been almost entirely abandoned.

The measurement of the extent of task accomplishment can be approached from either end, but it is more convenient to figure out the result, and, if this is below the standard, to turn to the record of conditions and there locate the cause of the discrepancy between the required results and those obtained. A gage for the measurement of the degree of fullfilment of task conditions is offered by the thermal efficiency of grate, furnace and boiler corrected for factors beyond the fireman's control.

Actually to calculate the efficiency of the boiler, furnace and grate is a tedious procedure, and is never done in power plants for a day, shift, fireman or gang of firemen working in teams. The simple method worked out by the author for use at the Warrior Ridge station requires the following data:

Coal records from store issue tickets and coal passers' reports compiled every eight hours.

Heat value of fuel determined by bomb calorimeter and value of coal in B.t.u. known for each coal pocket.

Amount of water fed to boiler (banked boilers fed separately) ascertained for same period.

Temperature of feed water.

Steam pressure.

Degrees of superheat.

These data are turned over to the station clerk who, from the slide rule shown in Fig. 2, ascertains the factor of evaporation on the basis of absolute boiler pressure, temperature of feed and of superheat, and by means of the power-plant log calculator, Fig. 3, he determines: the actual evaporation ratio; the factor of evaporation; the efficiency of steam genera- equivalent evaporation; the tion; the cost of fuel per 1000 lb. of steam; all per watch or per man. The results of these computations are entered upon the daily-report form, Fig. 4. The whole procedure takes on the average 18 min. of the clerk's time.

Every case of failure on the part of any fireman to secure on his watch the combined boiler, furnace and grate efficiency of 70 per cent. or above, is immediately investigated by studies of other records and recording charts of drafts, temperature of escaping gases, nature of boiler refuse, etc., and if no reason can be found there, an examination of the physical condition of the equipment and apparatus is made. The result of this investigation is recorded on a form for cause of lost bonus, Fig. 5. This method is particularly valuable and, outside of its direct advantages, provides an additional and continuous training of the men in careful observation of harmful factors of the slightest nature.

Every fireman is given a daily bonus slip, Fig. 6, by which he is informed as to the results of his work before

DAILY POWER PLANT REPORT

PENN CENTRAL LIGHT AND POWER CO.
STATION Warrior Ridge
FOR 24 HOURS ENDING 9 / 14 / '13 7 A.M.

BOILER ROOM	WATCH 1	WATCH 2	WATCH 3	ENGINE ROOM	WATCH A	WATCH B	WATCH C
COAL USED	48800	49200	34000	HYDRO ELECTRIC OUTPUT	980	850	30
WATER EVAPORATED	419800	408200	284000	STEAM GENERATED OUTPUT	21220	20450	15070
ACTUAL EVAPORATION	8.62	8.32	8.37	LOAD FACTOR	79.5	64.4	67.5
FACTOR OF EVAPORATION	1.2187	1.2185	1.2287	STEAM PER KWH	19.78	20.00	18.85
EQUIVALENT EVAPORATION	10.50	10.13	10.28	COAL PER KWH	2.30	2.40	2.26
EFFICIENCY OF GENERATION	73.4%	70.8%	71.8%	THERMAL EFF'CY. OF PLANT	10.71	10.27	10.73
COST OF FUEL PER 1000 LBS. OF STEAM	0.0815	0.0845	0.0833	COST OF FUEL PER KWH	0.00201	0.00204	0.00200

REMARKS:

COAL USED FOR BANKING 1 BOILERS DURING 6 9 HRS 55 30 MIN. 3000 LBS. COAL ANALYSIS BTU AVE B.T.U. 13900

TOTAL OUTPUT ____ KW HRS. THE ABOVE IS A TRUE AND CORRECT SUMMARY OF READINGS OBSERVED BY ME S. D. Port SIGNED

FIG. 4. DAILY REPORT FROM THE PLANT, SHOWING AVERAGE RESULTS

coming back to the next watch and, moreover, while he is proceeding with his work, he has, in addition to the previously mentioned instruments indicating the condition of firing, continuous information as to results that are being attained up to any moment of his watch. This is accomplished by having the coal weighing and water metering so balanced, that an even number of dumps of feed water and dumps of coal indicates that the ratio of evaporation is on the safe side of the requirements.

9	6	1913	I HAVE INVESTIGATED AND REPORT BELOW THE CAUSE OF LOST BONUS	DEPT. Electr.
MONTH	DAY	YEAR		DISTR. War. Ridge

BY O. Hawn ON JOB Firing

CONDITION Draft was set wrong

Due to leak in draft gauge

RESPONSIBILITY IS ALLOCATED TO Maintenance Man

REMEDY ATTENDED TO BY ME / SUBMITTED FOR APPROVAL Ordering Repair

S. D. Port
SIGNED

FIG. 5. RECORD OF CAUSE OF LOST BONUS

The record of attainment of the tasks by firemen devised by H. L. Gantt, and shown in Fig. 7, was adopted for general use by the above mentioned public-utility company. The illustration of this record kept from the start of task work at the Warrior Ridge station shows steady improvement and better habits of the men. While the May record shows only 68.7 per cent. efficiency of boiler and grates for the whole plant, the last month on the record showed an efficiency of 73.1 per cent. The number of day men falling short on the task is steadily decreasing. The number of men absent is chiefly due to days off and summer vacations, for the men work seven days a week. The departure from the principle of separate man's record made by the writer at first involuntarily, proved to be so gratifying, creating as it did a strong spirit of team work, that he has never attempted to split the record of two or three men working jointly firing one battery of boilers.

It will be understood that the men are paid a regular day's wage. In addition, those who accomplish the task which has been set them, in this case, the maintenance of a combined boiler, furnace and grate efficiency of 70 per cent. are paid a bonus. The maximum bonus would be equal to the amount of net saving accomplished under given circumstances, while the minimum bonus is, of course, equal to zero. When the bonus to be paid actually reaches either of these limits, it will lose its usefulness since it loses its stimulating effect, with the management, if the maximum, and with the men, if the minimum. Since in a average boiler house, the task results in about 25 per cent. saving on the coal bill, while the firemen's payroll is from 10 to 15 per cent. of the coal bill, it is evident that there is a considerable latitude for the adjustment of bonus.

In a boiler house, the amount of work per man per hour is constant and cannot be increased without knocking down the efficiency to a ridiculously low figure, but the number of foot-pounds of work can be reduced in an inverse ratio to the increase of efficiency, so that the question of preservation of a man's health, etc., eliminates any consideration of overspeeding. The conditions which were named for consideration are temperature of the room, ventilation, lighting, drinking water, restful seats and sanitary washrooms.

One familiar with the common layout of a power plant cannot overemphasize the importance of the above conditions to enable the men to live up to their tasks day in and day out. While engine rooms not infrequently offer very pleasant and sanitary surroundings, boiler houses, the most important part of any plant, are so built as to make them unbearably cold in winter and uncomfortably hot during the summer. Ventilation apparently serves either to fill the lungs with coal dust or to chill the perspiring men after cleaning their fires. Lighting is an unusual luxury, so that, after looking into the furnace, no man can read his gages or examine anything about the boiler. Good drinking water is rarely provided and restful seats with backs (seats without backs are equal to no seats at all) were never found by the writer in any boiler house; yet the mere fact that the firemen, if provided with seats having backs, can get through the cleaning of fires in 18 min. per 100 sq.ft., while without them, they consume at best 24 min., apparently should convince any unbiased mind.

Finally, the time element in relation to task setting for men, particularly, if the work requires a considerable strain, must be settled by examination no less careful than the study of the time rate of driving boilers. When, however, as in the case of firemen, both physical strain and attention are required, it was found that with strong,

FORM BA3D1A

DAILY BONUS SLIP

CHARGE _____

DATE September

NAME J. Dearing NO. _____

DISTRICT - PLANT Warrior Ridge

HOURS DAY WORK	4
HOURS BONUS WORK	4
HOURS BONUS EARNED	1
TOTAL HOURS FOR DAY	9

REMARKS 71.8% - 4 hrs. firing on 3rd shift,
4 hrs. passing coal for sick coal passer.

SIGNED S. D. Port

FIG. 6. DAILY BONUS STATEMENT TO FIREMEN

healthy individuals the limiting fact or number of hours of profitable work is set, not by physical exhaustion but by weariness of spirit. Other conditions being equal, a fireman on a 12-hr. watch is found to be about 4.5 per cent. less efficient than the same man on an 8-hr. shift.

This time-limiting factor on human efficiency, taken in conjunction with a scientific certainty in determination of the most advantageous thermal efficiency, forms the ground on which the author rejected the sliding scale of

bonus based on results exceeding the task set by various degrees. The task set must be so little below the most advantageous point, that it could be reached with greatest benefit to all concerned, and it is not desirable either to fall short of or to considerably over-reach it. Offering extra compensation for excess of the task requirements means, in the final analysis, either that the investigator has not correctly determined both limits or that the management tempts a man to do more than the average employer dares to ask directly.

Discussion

William Kent criticized the method of presentation and the mathematics of the paper, and took particular exception to a diagram purporting to show the relation between efficiency and rate of driving for boilers of different types. One type of boiler is as efficient as another if properly set and operated. The owner had tried to go too far in his mathematical analysis and had not gotten anywhere.

D. S. Jacobus, of the Babcock & Wilcox Co., said that frequently after getting up the efficiency of a plant to a high figure he had endeavored to get the management to introduce some sort of a bonus system. He had not, however, attempted, and did not believe it possible, to get up a system where the men will individually be paid bonuses. The whole organization of the boiler room must be taken together, and he did not believe that one could differentiate between the men in any other way than to get the right sort of firemen and to get rid of the men who were poor. In a station where bonuses are paid, the men soon find out that the man who carries his fire the most uniform and steady is the one who gets the best efficiency. The poor fellows who are working hard and trimming their fires and making the steam, because they do not know the methods employed by the other men, are penalized, and will fall back, and the result is that there will be a feeling between the men, and they will work against each other.

Of two plants one may run comparatively steady and the other carry a swinging load. The plant which is running steady will have a much higher output than the other, and the firemen who have a swinging load will apparently be less efficient, while the firemen who have the steady load will have a higher efficiency. It is hard to cover that point with a bonus system. The other way of handling the situation is to put the right sort of a man in charge of the boiler room and make him responsible for getting the right kind of a result.

He did not believe that the general idea that the firemen are always against any improvement is correct. He had had considerable experience with going into fire rooms and getting the best out of the men. If the men once see that you are with them they will be with you. No one can go into a boiler room and present a lot of half-baked ideas and expect the firemen to follow them and

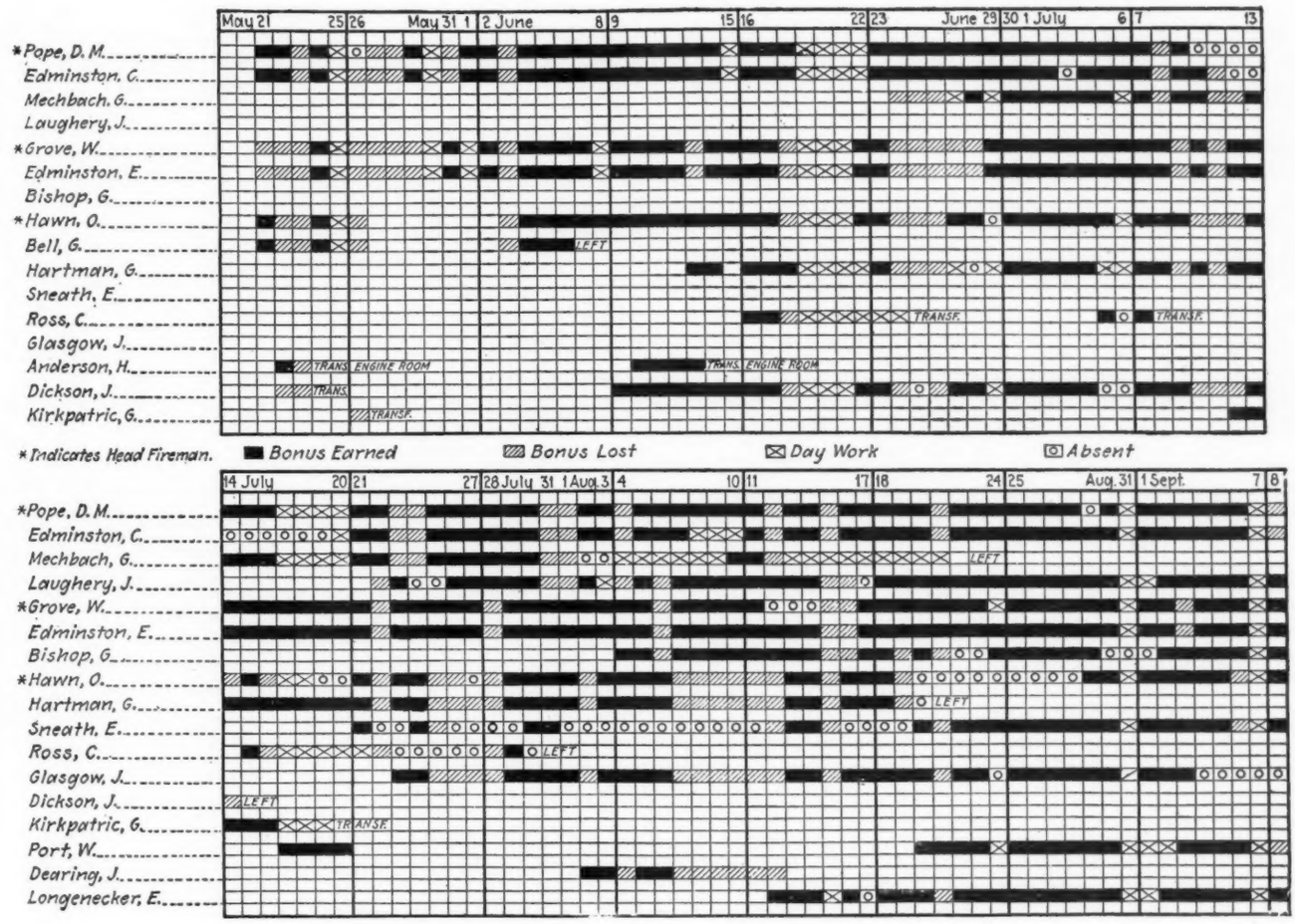


Fig. 7. Graphical Bonus Record

to be jumped on for something which may not work right. If you go in and the firemen feel and know in a certain sense that you are one of them, you can get the men to do what you want. It is seldom that one can apply the bonus method satisfactorily, but you can put a live man in charge and give the men some increase in pay in proportion to the amount that they can save by really exerting themselves to the utmost. He agreed with Mr. Kent that the author's method of getting at what a boiler should do is quite incomplete. For example, as far as he could see, there was nothing to connect the baffle arrangement in the particular boiler with the efficiency; but by changing the baffles in a particular boiler you can alter the heat transmission 50 to 100 per cent.

H. G. Stott, of the Interborough Rapid Transit Co. of New York, also took issue with the curve which purported to show the most economic loading for various types of boilers. His experience is that the type of boiler has very little to do with the question. It is entirely a question of the furnace, the combustion of the fuel, and one can perfectly easily drive a boiler up to 400 per cent. of the rating or even more. The point as to whether the tubes are arranged in one direction or another is immaterial. In the table, the fire-tube boiler with superheater is given as the most economical one. He did not think this was quite so. He had had efficiencies on the regular Babcock & Wilcox boiler equal to those shown in the curve, and this boiler can be carried to practically an unlimited rating. It must not be forgotten that there is mixed up with this question another, which it is absolutely impossible to separate from the consideration of the matter, and that is the economics of the plant. The efficiency may be run down during the peak load to 60 per cent., and yet the operation be more economical when the fixed charges are taken into consideration than when the plant is running at 80 per cent. When running at 80 per cent., the boilers must be run at about 70 per cent. of the so called rating, and if the fixed charges and the operating charges are plotted, it will be found that their sum is relatively unimportant for the two or four hours a day during which the peak load exists. The important thing is to take the fixed charges into account and to keep down the number of boilers on the line and also the number of banked boilers.

He is thoroughly in favor of educating the firemen, but from a different point of view. He believes that with modern equipment in the boiler room we should no longer have firemen at all but combustion engineers. The time has gone by when we are going to take an illiterate man and train him to be an expert in combustion. We do not think of doing this in our construction or engineering work. On that work we employ men who have graduated from technical schools. He presumed that we cannot get that type of man to go into the boiler room yet; but the time is coming when we will be willing to pay more to the man who operates the boiler than to the man who operates the turbine room or the engine room, because one can make no change in the economy of a plant and the other can make from 5 to 10 per cent. difference; so that he looks for the time when we can completely equip a boiler plant with modern combustion appliances, with stokers which are practically automatic and require little attention, and then we must have engineers and not firemen at all in the boiler room.

R. J. S. Pigott, of Columbia University, also directed attention to the diagram purporting to show the economic loading for different types of boilers. He said that there is still a good deal of misapprehension among engineers as to the economic point of loading, either of the boiler or a turbine. The efficiency of the boiler and of the turbine has much the same characteristic; namely, there is a dome or high point at some place in the load. With the turbine it is usually at full load that the best efficiency occurs. Beyond this point there may be some 25 or 50 per cent. capacity allowed for overload. The best loading occurs very low in the total capacity of the boiler, somewhere about one-third or one-quarter of the maximum capacity. The total rating of the engine room consists not only of the usual rating of the turbine but must include that of the auxiliaries necessary to run the turbine. In other words, the steam rate of the turbine may be 12 or 13 lb. per kw.-hr. at its best load, but when we superimpose on that the steam required to drive the auxiliaries, the water rate is much higher, and the best water rate, including the auxiliaries, is at a higher load always.

This is also true of the boiler room. The auxiliaries required to drive the pumps, forced-draft fans and possibly induced-draft fans, boiler-feed pumps, etc., must be taken into account. While the condenser auxiliaries run with a practically constant amount of steam, no matter what the load on the turbine is, the units of the boiler room are different, and require somewhat less steam at lighter loads than at full load. The total steam consumption of a centrifugal boiler-feed pump, for instance, at zero delivery, is seldom less than 50 per cent. of the steam at full load on the pumps. If the steam required for the auxiliaries is subtracted from the total steam delivered by the boilers, and the result divided by the boiler horsepower, it is usually found that the net efficiency of the boiler room is at a much higher load on each boiler and is not at the best load on the boiler itself.

Edward A. Uehling, of the Uehling Instrument Co., said that one thing that this and Mr. Parker's paper upon the Delray boilers had brought out very fully, was that in order to obtain boiler efficiency the boilers must be tested by experts and put into proper condition for getting high efficiency. Next and just as important is the fact that means must be furnished to the boiler room, the fireman, or whoever is in charge, to maintain the efficiency that has been attained. This cannot be done by simply making a test once in a while; it must be done continuously.

There may be and doubtless are numerous methods by which control over the firemen and control over the efficiency of the boilers can be maintained. One way is to measure the water that goes in with the coal and the steam flow. Correlate these items and you know what the fireman has done. Another way is to control the combustion, the rate of driving the furnace, and also the heat which is wasted up the chimney. Either of these methods will suffice to obtain the proper regulation. The question is, which is the better, which is the cheaper in installation. For the last a CO_2 instrument is necessary. We have heard considerable about the difficulty of keeping these instruments in operation. There is less difficulty in keeping the CO_2 recorder in operation than in keeping a pump in operation. The situation is this: The man who is in charge of the pump is discharged if he

does not keep it running properly. There is nobody in responsible charge of the CO_2 instrument, and if it is out of order today they say, "We will fix it tomorrow," and that is why it is not always kept up to the mark.

There are installations where they have 20 units, each fitted with a pyrometer and a CO_2 recorder, which instruments are kept in perfect order by an illiterate Italian. He may not understand all about the scientific principles of the instruments but he knows just what to do. The water level has to be kept up, the clock has to be wound, and the absorbing reagents to be changed. When that is done properly, and the filters are taken care of, that is all there is to it.

As to the capacity of a boiler, Doctor Jacobus referred to the fact that the fireman gets onto the fact that if he fires easily, he can get a high CO_2 and, consequently, get the bonus, and the poor devil who is making the steam does all the work and gets nothing. Therefore, it is necessary to know the rate of driving, and when the rate of driving is known and the CO_2 is known, and the stack temperature is known, you can give individual bonuses, and that is the only way in which you can select the best firemen. You can tell then whether each fireman is doing what he ought to do.

❋

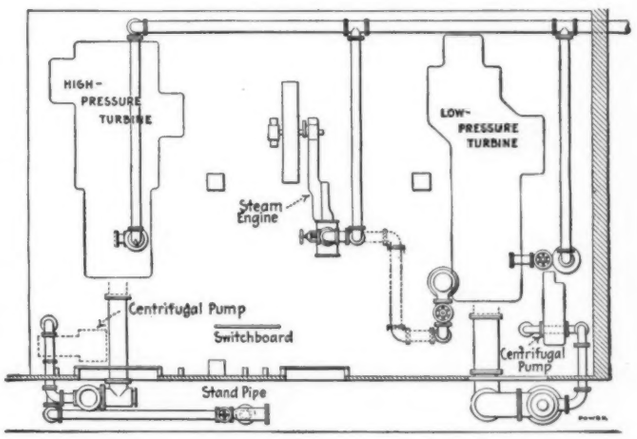
Low-Pressure Turbine in Veneer Mill

The Astoria Veneer Mill & Dock Co., of Steinway, L. I., is doing a large business in hardwood veneer and lumber. Naturally, a great deal of power is required to handle the logs and in the various processes of manufacture. Some of this power is supplied direct by engines in the individual mills and some by motors taking current from a central plant. There are, of course, numerous hoisting engines and steam feeds for the carriages of the sawmills, and at times as much as 500 hp. in boiler capacity is required for steaming the logs, previous to trimming off the veneer.

To supply this steam, the plant is equipped with four Parker water-tube boilers aggregating 1500 hp. There is one 500-hp. unit, two 350-hp. boilers and one of 300-hp. capacity. The fuel is sawdust and chips. The quantity of coal required is usually small, but, of course, varies with the supply of refuse. All the slabs and edgings from the sawmill are ground up in a mill hog and turned into the conveyor which carries the sawdust, so that by the time the material reaches the boiler room, the fuel is thoroughly mixed.

In the veneer-cutting room, there are two 250-hp. simple engines, one of Skinner make and the other an Erie. These engines are belted to line shafts and their exhaust is used for heating and drying purposes. In the cedar mill, which turns out cigar-box lumber, there is a 50-hp. Erie engine, which is belted direct to a rotary cutting machine. Excluding the numerous hoists and steam feeds, previously mentioned, the balance of the power is supplied from the central plant. Here is a 350-hp. Clark Bros. 20x24-in. simple engine, which is belted to line shafting supplying power to the sawmill. There is also a high-pressure 300-hp. De Laval turbine driving two 100-kw. Crocker-Wheeler generators delivering two-phase current at 440 volts. This machine supplies a large number of motors varying in capacity from 3 to 140 hp. Naturally all of these motors are two-phase and are distributed throughout the various mills. The turbine exhausts into an old-style, single-jet Schutte & Koerting eductor condenser equipped with a standpipe. With 700 gal. of water per min., the condenser is capable of holding a vacuum of 27 in. A 15-hp. Chandler & Taylor engine belted to a Hobart direct-current generator supplies the lighting. The power engine and this unit have been run noncondensing.

With the installation of a new sawmill, more power was required, and, to obtain this power with little or no additional steam, a mixed-pressure turbine was installed by the Turbine Equipment Co., of New York City. This turbine is also a De Laval rated at 200 kw., which it is designed to give on a pressure ranging between 2 lb. gage and atmospheric. The turbine drives two 100-kw., two-phase Allis-Chalmers generators at a speed of 900 r.p.m. The turbine is equipped with two sets of nozzles, one for high-pressure and the other for low-pressure steam, either of which may be used as conditions demand. From all indications, however, there will be plenty of exhaust steam, the main source being the 350-hp. engine driving the older sawmill. A connection into the exhaust main supplying the turbine from a turbine-driven pump has already been made, and it is the intention to make other connections so that the exhaust from the lighting unit and perhaps from the steam feeds of the sawmill may be used.



LAYOUT OF CENTRAL PLANT IN VENEER MILL

Naturally, the mixed-pressure unit is operated condensing, a vacuum of 28 in. being obtained by a Schutte & Koerting multi-jet eductor condenser equipped with a vacuum breaker. In this installation there is no standpipe, and the water is delivered direct from the pump into the condenser. The mixed-pressure turbine has been in operation for a number of weeks and has been operated in parallel with the high-pressure turbine, although favorable conditions are required for this method of operation. In case of an emergency, Edison breakdown current is available.

As the fuel has been largely waste from the plant, no records have been kept. Previous to the installation of the new sawmill, the amount of this refuse was just about sufficient to fulfill the demands, and any additional power would have required the use of considerable coal under the boilers. With the present arrangement no more fuel is required and enough exhaust steam is available to supply the new unit, so that the additional 200 kw. is supplied practically for nothing, excluding, of course, interest and depreciation on the investment.

ELECTRICAL DEPARTMENT

Long-Distance Water-Level Indicator

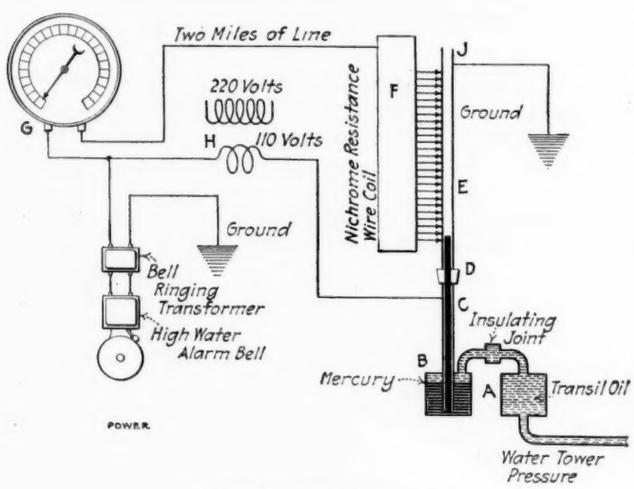
By A. V. Youens

The municipal water-works and power plant at Palo Alto, Calif., is located about two miles from the reinforced-concrete water-tower storage which floats on the water-distributing system.

This tower is of cylindrical form, 76 ft. high and 35 ft. in diameter. The lower part of the tower is an open room for use as an auxiliary pumping station while the upper section forms a water storage of 155,000 gal. capacity. The roof of the pumping-station room is of dome shape and forms the bottom of the water reservoir. The roof of the tower is also slightly dome shape and is of reinforced concrete. Iron steps that were built in during the construction lead to the top of the outside wall of the tower.

As it is not a particularly desirable job to climb to the top of this wall for general inspections there were objections to the regular float type of water-level indicator. A device near the ground was much to be preferred.

Experiments were made with a mercury column, balanced against the water-tower pressure, having a float in the mercury by means of which, through a cord, we intended to actuate a sliding contact. The float in mercury was not a success as its response to changing of mercury level was not sensitive or reliable. The float idea was dropped but the mercury column was retained and has worked out successfully in the water-level indicator described below.



Water-Level Indicator

Referring to the illustration, the bottom of chamber A is connected by ¼-in. iron pipe to the bottom of the concrete water tower. Chambers A and B, both made of iron fittings, are interconnected by short iron pipe in which an insulating joint is inserted. A ¼-in. iron pipe C having running threads at the lower end is close to the bottom of the chamber B and a reducer D into the top and larger end of which is screwed a hard-rubber tube E, the bore of which is practically the same as the ¼-in. pipe, is provided. Properly spaced and entering through the wall of this rubber tube are 25 iron machine screws which correspond to a 25-ft. working range of water level in the concrete tower. Each screw is permanently connected by a flexible copper wire to a predetermined point of the resistance coil on the wooden drum F. The lowest or No. 1 screw connects to one extreme end of the resistance coil while the other end is connected to one side of a galvanized-iron line leading to the water-works two miles distant, and after going through the water-level instrument G the electrical circuit is completed through the 110-volt secondary of the transformer and finally connects to the ¼-in. pipe C.

Chamber A and its connecting pipe to chamber B are filled with transil oil which is, of course, a good insulator of electricity. As already stated there is an insulating joint in the short pipe connecting chambers A and B. Therefore, the pressure pipe to the tower, together with the water column it contains, is insulated electrically from chamber B.

Chamber B contains mercury and this mercury rises up columns C and E corresponding to the pressure exerted on top of the mercury, which pressure is due to water level in the tower.

The small transformer H is energized from the regular municipal lighting primaries and located approximately at the center of distribution. The primary voltage is controlled by an induction-feeder regulator at the power plant, and, therefore, the secondary voltage serving the water-level indicator is fairly constant.

The water-level instrument, located on the switchboard at the water-works and power plant, is a long-scale voltmeter, the face of which we removed and substituted one having an evenly divided scale of 25 block divisions. Each block division is a little over ½ in. of scale. Therefore, the instrument pointer can swing within a range of ½ in. and still be on the same block corresponding to a certain foot depth of water in the tower. With this arrangement of scale and pointer swing a corresponding voltage variation is allowable without affecting the accuracy of the water-level indicator equipment.

The proper spacing of the 25 screws in our particular case was calculated in the following way (not taking account of the negligible correction for difference in relative weights of transil oil and water):

Let

M = Area, in square inches, corresponding to diameter of mercury chamber B;

N = Area, in square inches, corresponding to bore of pipe C or rubber tube E;

X = Lowering, in inches, of mercury level in chamber B corresponding to one foot rise in water level in the tower;

Y = Rise, in inches, of mercury in rubber tube E corresponding to lowering X in chamber B.

Then

$$M\ X = N\ Y$$

In our particular case

$M = 14.75$ *sq.in.* and $N = 0.104$ *sq.in.*

Substituting values for M and N we have:

$$14.75\ X = 0.104\ Y$$

$$X = \frac{0.104\,Y}{14.75}$$

also,

$X + Y = 0.883$ *in.* (1 *ft. water* = 0.883 *in. mercury*)

therefore,

$$\frac{0.104\,Y}{14.75} + Y = 0.883$$

or

$$0.007\ Y + Y = 0.883$$

Then,

$$Y = \frac{0.883}{1.007} = 0.877\ in.$$

for each foot of difference of water level in tower.

Or the spacing of screws might be determined by trial. Having the location of top-contact screw No. 25 established, the water in the tower could be allowed to lower 25 ft. and the corresponding level of mercury in the rubber tube E noted, which would give the location of the contact screw No. 1. The distance between these two points would represent the total working range of mercury column. Then with a pair of dividers the intermediate-contact screw locations could be laid off.

The permanent height of the top screw No. 25 with reference to chamber B was established by filling the concrete tower to the desired high-water level and then lowering an insulated wire down the ¼-in. pipe C (previous to cutting C off to add the rubber tube E) until the exposed end of the wire touched the top of the mercury column and closed the buzzer circuit-testing set. Then the iron pipe C was cut off and threaded so that when the rubber tube E was screwed in place the top-contact screw was located at the right height.

The resistance coil on the drum F was made as follows:

A wooden cylinder was turned out in a lathe and a V-thread of ten to the inch cut along its length. In fact, the cylinder was of soft wood and the thread was pressed in by a wheel cutter taken from ordinary three-wheel pipe cutter and held in the tool post of the lathe carriage. Then No. 28 Nichrome resistance wire was guided over the tool post into the thread on the cylinder as the carriage traveled back along the lathe bed with the same lathe gears in as were used in cutting the threaded groove. This afforded a very simple and convenient method of winding the resistance wire in very close turns so that the maximum length of wire could be put into a minimum space.

The 25 permanent points of connection were then located in the following way:

The two ends of the two miles of line wires were temporarily joined together at the water-tower end of the line, leaving the mercury tube out of consideration for the time being. A series circuit was then made up of the two miles of line, 110-volt secondary winding of the transformer, water-level instrument and enough of resistance coil on the drum F to swing the instrument needle to the middle of the scale division 1. This gave the location of the lowest point No. 1 on the resistance coil and connection was made by fastening with small blind staples the bared end of a piece of single lamp cord in the threaded groove of the drum against the bare resistance wire. The loose end of this flexible cord was then attached to the short length of the bare wire (serving temporarily in place of mercury column).

The one end of a second piece of flexible cord was fastened to the wire serving as a mercury column and then, by trial, touching the other end of the cord at points along the resistance coil, above location No. 1, we located a point No. 2 that raised the instrument pointer to the middle of the scale division 2. In like manner all the 25 points on the resistance coil were determined, one by one, in consecutive order. With all 25 flexible cords connected, forming parallel circuits between the resistance coil and wire serving as a mercury column, the instrument needle indicated 25 on the scale corresponding to 25 ft. of water in the tower.

The resistance drum F was then taken to the water tower and mounted vertically opposite the rubber tube E. The 25 screws in the rubber tube were then connected to corresponding flexible leads from the resistance coil, after first removing the short length of wire which had served temporarily in place of the mercury column.

Finally one side of the tower end of the two-mile line was attached to the upper end of the resistance coil and the other end fastened to the ¼-in. pipe below the rubber tube.

From the above description and reference to the illustration the action of the water-level indicator will be readily understood. With a very low water level in the tower the top of the mercury column may be below the bottom screw No. 1 of the rubber tube E in which case the electrical circuit would be open and the water-level instrument at the water-works would indicate zero. Then as the water level rises, the pressure in the mercury chamber B increases, which raises the mercury column until it reaches the contact screw No. 1 when the instrument at the water-works shows 1 ft., and so on up and down the working range.

The object of the insulating provisions, as already described, was to afford a ground-return circuit for ringing a high-water alarm bell. The alarm circuit is made up of this ground return and part of the water-level indicator circuit which takes in the transformer secondary and mercury column.

The extreme top screw J is located at a point in the rubber tube E corresponding to the overflow of the water tower (or any high-water point desired). This screw is grounded. Also, at the water-works, one primary terminal of the bell-ringing transformer is grounded and the other attached to the side of the line that leads from the water-level instrument through the line transformer to the ¼-in. iron pipe C. Therefore, when the mercury column rises to the point J the bell-ringing circuit is closed through the ground and mercury column and the bell alarm is sounded. Of course, at this high-water alarm point the ground return would form a shunt path, practically cutting out current through the water-level instrument, thereby causing the pointer to drop toward zero. But this condition need cause no confusion because of the meaning of the high-water alarm. Upon closing down the pumps the water level in the tower would drop and as soon as the mercury column lowered sufficiently to break contact with the screw J conditions would at

once adjust themselves and the needle of the instrument would immediately rise to division 25 and remain there until water lowered or raised to next foot mark.

The above described water-level indicator was designed by the writer about three years ago. A glass tube with platinum contacts, which was kindly constructed for us by professors in the chemical department of Stanford University, was originally used instead of the present rubber tube. But for some unknown reason this tube was one day found cracked at one of the platinum contact leading-in wires. This may have been due to jar from the many trains on the very near-by railroad line or possibly from heat due to arcing at contact during operation or perhaps due to some inherent strain in the glass tube. The rubber has thus far given no trouble whatever.

Fire Hazard in Turbo-Generators*

By G. S. Lawler†

The chances of electric generators of the older types being seriously injured by fire in the event of some part of the insulation failing is slight. Occasionally arcing will ignite the insulation, but it is seldom that the fire will spread much before it is extinguished. This freedom from fire damage is due principally to the comparatively low speeds, the accessibility of the combustible insulation, and the fact that the machines being of large mass per unit capacity, the insulation is considerably distributed.

This condition is reversed in generators of the turbo type. The chief causes of the increased hazard are as follows:

The volume occupied by this type is much less for the same capacity than that of the older types so that the combustible insulation is more concentrated. Also the amount of combustible insulation on the higher-voltage generators is naturally greater than that in the low-voltage machines.

These generators being of large capacity in many instances, an enormous amount of energy is involved in a short-circuit, especially at the instant the short occurs and as the arc is confined in the limited space with the combustible insulation, it would seem impossible for the insulation to escape being set on fire at many points simultaneously.

The machines are cooled by forcing large quantities of air through the spaces between the conductors and the large and constantly renewed supply of oxygen will hasten combustion after it is once started.

The generators are totally incased with the exception of the air inlets and outlets and even these in some designs are under the machines. This construction prevents access to a fire and much valuable time will be consumed before extinguishing agents can be used effectively. When the field current is cut off, as is necessary in case of a short-circuit, the only means of bringing the rotor quickly to rest is lost and it will continue to run for a long time after the steam has been shut off. This continued rotation is not conducive to the quick extinguishing of a fire.

While the generators may be free from fires during the earlier portions of their lives owing to the proper use of reactances which prevent external troubles seriously affecting the machines, as they get older the ordinary causes of breakdown of insulation are likely to occur and fires result.

Undoubtedly the manufacturing companies have given serious thought to the reduction of the fire hazard in turbo-generators and have employed all means practical at the present time to this end, but there is still much to be desired. The following means would seem to minimize the chances of a serious fire:

(a) If a suitable material could be found, a noncombustible outer covering could be placed over the insulation on the stator end connections. This would greatly delay the spread of fire and even if no other protective means were taken, would undoubtedly prevent much serious damage.

(b) If a noncombustible outer covering should be put on, its advantages would be partially lost in time unless the cooling air were freed of the dirt and oily vapor liable to be in it. This could be done by filtering.

(c) Means could be provided for cutting off the air supply in case of fire in generators by placing dampers in the inlet ducts designed so as to be normally held open by fusible links.

(d) Arrangements could be provided for the quick introduction of carbon-dioxide gas into the machines. The carbon dioxide could be kept in liquid form and piped through valves, expansion tanks, etc., to the generators. The valves could be arranged to be opened by the closing of the air-inlet dampers, so that the gas would be automatically introduced into the generators.

The employment of some efficient method of reducing the fire hazard in generators of the turbo type either along the lines mentioned or in some other way is important. The value of these generators is great and the damage by fire may amount to a considerable proportion of the first cost. It is probable that the damage is more likely to occur toward the end of the life of the generators, but even then the loss may be large, both directly and indirectly. The large central stations have reserve units, so that the increased damage due to fire in one of their generators would probably not affect the continuity of the service, but the increased time necessary for repairs may be long and during this time the reserve capacity will be weakened. In the case of industrial plants the longer time needed for repairs might be serious. Many manufacturing concerns who generate their own current depend on only one unit and, therefore, their whole production, or a large part of it, would be affected.

*From paper read at annual meeting of the A. S. M. E.
†Electrical Engineer, Inspection Department, Association Mutual Fire Insurance Companies.

Electric Distribution at the Canal—During the year it was decided to install for the transmission line an overhead system of 44,000 volts, extending from Balboa to Cristobal, and connecting the Gatun hydro-electric power station with the present Miraflores steam-power station, so that they may be operated separately or in parallel, as necessary. Four substations are provided, and located at Cristobal, Gatun, Miraflores and Balboa. The complete line consists of duplicate three-phase lines, one of which is carried on each side of track-span bridges spaced 300 ft. apart on tangents and 200 ft. on curves along the whole length of the Panama R.R. The bridges are of structural steel, with a clear track span of 36 ft., and an overall height of 40 ft. The conductors are to be 2/0 stranded copper wire spaced with a clearance of 5 ft. They are supported from brackets outside of towers, with three-part suspension insulators, with noncorroding connecting links to allow a maximum life and a minimum of line troubles.—"Canal Record."

GAS POWER DEPARTMENT

The Large Gas Engine in Europe*

By Prof. P. Langer

The tendency to utilize in gas engines the enormous quantities of waste gases from blast furnaces had its inception in Germany about 20 years ago. The two-stroke-cycle system seemed suitable for large engines, but full success was not attained until about 11 years ago when the large gas engine was brought to a high state of perfection by the Maschinenfabrik Nuernberg in the form of the double-acting four-stroke-cycle type, with two cylinders in tandem.

Regulation of Large Gas Engines

The attempt to attain stratification of the mixture inside the cylinder has led to very complicated valve-gears. It was hoped that a gas valve which remained open during only a part of the suction stroke would direct the gas in such a manner that a combustible mixture would be present at the point of ignition even under the lightest loads, while the balance of the combustion space would be filled with inert air. The result, however, did not justify this hope.

Throttling of gas and air simultaneously, or in other words, regulation of the quantity of mixture only, is to be preferred to the throttling of gas only, as the former method is less sensitive and makes possible a more certain control by the governor. But even the simplest method of quantity regulation will give satisfaction only if the action of the governor upon the throttle valve has been given careful consideration. It is wrong to let the governor act in such a way that the valve opening is proportional to the travel of the governor sleeve, as the following consideration will show:

The result of throttling is to reduce the quantity of mixture drawn into the cylinder during each stroke. The volume of charge remains the same, as the cylinder is always completely filled, but its density becomes less, also its weight and the amount of energy supplied.

These relations are shown in Fig. 1. Starting with a certain velocity C, of the mixture through the valve, which is determined by the opening of the valve; the curve shows the velocity as a function of the position of the governor. This velocity can be produced only by a certain drop in pressure as the mixture passes to the cylinder, so that the law according to which the absolute pressure in the cylinder changes is also definitely determined. The shape of this curve shows that the lower part of the travel of the governor sleeve is almost without influence and that the total regulation is limited to the upper travel. This results in marked irregularity of the indicator diagrams, as the smallest motion of the governor causes considerable changes in the quantity of mixture supplied.

The remedy is found in changing the connection between the governor sleeve and the throttling mechanism, so that in the low positions of the governor the throttling action is more intensive than in the upper positions. This can be accomplished by off-setting the connecting link between the governor and the throttling valve.

Even the best scheme of regulation will not avail, if the proportion of mixture is not properly controlled. In engines that have separate pumps for air and gas, as is usual in two-stroke-cycle machines, where air and gas are furnished in measured quantities, it is comparatively easy to get the proper proportion, at least at full load. Difficulties are found, however, in four-stroke-cycle machines, where gas and air are drawn in by the working piston in parallel. In this case the proportion of mixture is not readily controlled, because the quantities drawn in depend not only on the free opening of the admission valve, but also on

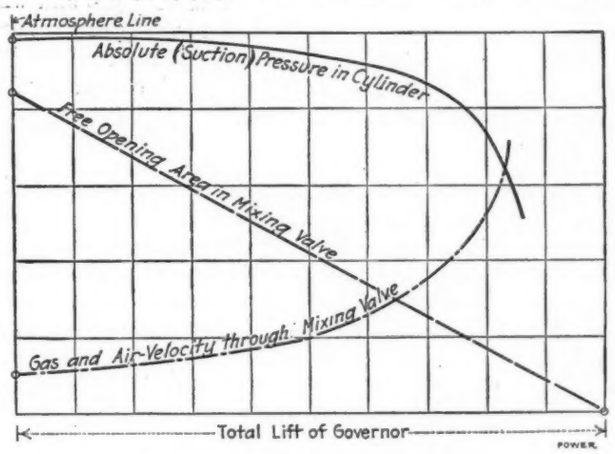

Atmosphere Line
Absolute (Suction) Pressure in Cylinder
Free Opening Area in Mixing Valve
Gas and Air-Velocity through Mixing Valve
Total Lift of Governor
POWER

Fig. 1. Illustrating Action of Governor on Throttle Valve

the product of this opening area and the velocity of flow through it. Incidental changes in pressure may influence this velocity strongly. The difference in specific gravity must be considered when deciding upon the proportions of the ports for correct mixture in engines that use gases lighter than air. Disregard of this leads to too rich mixtures and the engine becomes choked with gas. The many failures of engines working with coke-oven gas are partly explained by wrongly proportioned gas ports. The intake velocity in the mixing valve must be at least 1000 ft. per min. to avoid disturbing variations of the mixture due to accidental changes of the gas pressure. Velocities of about 1200 ft. per min. are considered normal. In order to avoid too intensive a throttling action and consequent reduction of power, the piping and other passages leading to the mixing valve must be proportioned liberally, so that the total drop in pressure is advantageously concentrated within the valve itself.

For a long time difficulties were experienced in driving variable-speed blowing engines by four-stroke-cycle gas engines. In most cases the gas arrives at the mixing valve under a pressure of several inches of water, while

*Presented at the annual meeting of the American Society of Mechanical Engineers.

the pressure of the air is somewhat less than atmospheric. When the machine is run slower the suction action of the piston is reduced and the intake velocity of the air decreases more rapidly than that of the gas, until finally it is reduced to such an extent that nothing but gas enters the cylinder. It is evident that, even before this

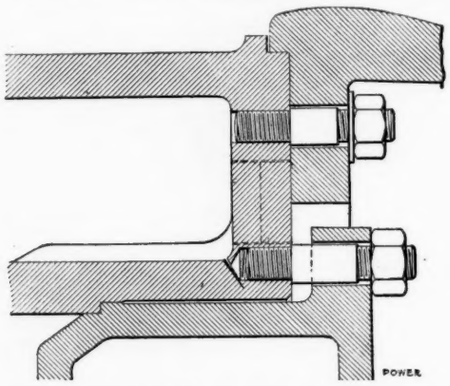


FIG. 2. ONE-PIECE CYLINDER, SHOWING COMMON LOCATION OF CRACK

point is reached, the engine will choke with gas and will stop. A governor which regulates the quality of the mixture would only favor this suffocation of the engine with gas. In such cases the conditions are improved by intensive throttling at normal speed.

CYLINDERS

Improvements in design as well as improvements in foundry practice have greatly reduced the breakage of cylinders. Views upon the most suitable shape still differ considerably, however. Some designers, after careful experiments, have abandoned the split-jacket cylinder in favor of the normal one-piece cylinder, while others have done exactly opposite, and split not only the jacket, but also the inside cylinder. The one-piece cylinder is just as strong as the split one. The latter has come principally from the desire to avoid initial stresses in the direction of its axis, which put the inner cylinder under tension, because in casting it cools later than the rest of the casting. Besides, by casting the two halves separately, it was attempted to obtain as dense a wall as possible for the combustion chamber. Finally, splitting the cylinder has the advantage that customers who consider a cylinder liner the proper construction can be satisfied, inasmuch as the insertion of liners in one-piece cylinders presents some difficulties.

Besides simplicity and the absence of the danger of leakage in the highly strained cylinder joint, the one-piece cylinder allows a better transmission of the forces from the cylinder to the frame. The fact that one-piece cylinders frequently broke at the place indicated in Fig. 2, caused an overestimation of the stresses in the casting. Closer investigation shows that the breaks are caused simply by making the part between the cylinder and flange too weak. The wall, besides being too weak originally, is further weakened by the large number of cover studs and the break is further induced by excessive tightening of these studs. This can be remedied by properly reinforcing the point of danger and by placing the joint shoulder on the outside.

While these breaks have their origin in the stresses set up by irregular cooling of the casting or by irregular heating in operation, cracks of an entirely different nature have been observed on the walls of the combustion chamber. These so called fire cracks always start in a place where the transmission of heat to the cooling water is impeded (see Fig. 3). In the smooth and homogeneous wall the differences in temperature of the different strata are small and the temperature of the wall is comparatively low, as long as accumulated scale or similar causes do not offer an obstacle to the transmission of heat. When, however, the rate of transmitting heat to the cooling water is reduced, there will be accumulation of heat, causing a rise in temperature during the expansion and exhaust strokes. The material will tend to expand according to the average temperature of the wall and it will be able to do this without resistance because it is under tension on account of the stress in the casting. In operation, therefore, the stress will be relieved. On account of temperature differences, however, in different strata of the wall, there will be stresses in the wall itself, compression in the hotter zones and tension in the cooler ones. As soon as cold mixture is admitted during the next suction stroke, the surface of the wall is cooled

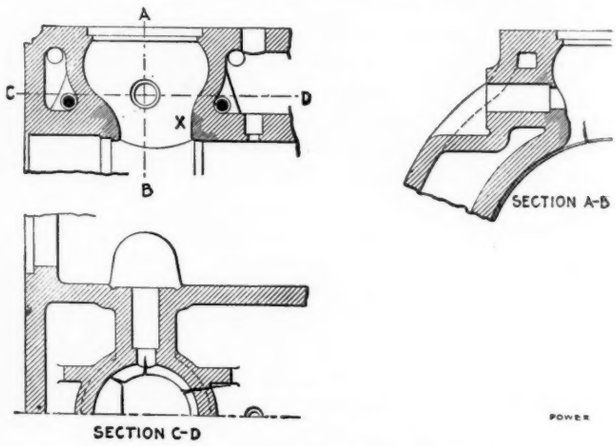


FIG. 3. SHOWING FIRE CRACKS

intensively, and the inside layers of the wall cannot follow rapidly enough to cause the establishment of settled conditions corresponding to this flow of heat.

The occurrence of a crack, which in the beginning is scarcely ⅛ in. deep, apparently relieves the stress to a certain extent and only the natural tendency of the cast material to continue to break, together with the external mechanical forces, causes the crack to open further. In most cases drilling and calking at the end of the crack will stop this. The timely discovery of the crack is, however, rather difficult, as it is not open after the wall is uniformly cooled.

The first step in combatting the occurrence of these cracks is to reduce their real source, that is, the differences in temperature, to an amount that is harmless. As the sudden changes of temperature are caused by the very nature of the gas-engine cycle, these attempts must be confined to avoiding all irregular ignition and slow combustion. Furthermore, it is necessary to make the conductivity of the wall uniform in order to avoid all accumulations of foreign material.

The commonly used globe or onion-shaped passages for inlet and exhaust valves are therefore not suitable, and lately the form shown in Fig. 4 has been preferred.

Cast steel is not a suitable material for gas-engine cylinders. The larger expansion due to heat as compared with cast iron and the very much higher modulus of elasticity causes increased stresses, while the strength of cast steel is not proportionately greater.

Increasing Output of Large Engines

The principal task upon which the gas engineer is laboring, besides that of enhancing the reliability of the machine, is that of making it cheaper, partly by simplifying its construction and partly by increasing its output. At present it can hardly be imagined that the gas engine can be made cheaper by making its construction simpler, now that the complicated valve-gears have disappeared. Reduction of weight is not to be recommended. Until recently experience has demanded a continuous increase of engine weights. Economy in material would reduce reliability and the life of the machine.

Somewhat better prospects appear in the attempt to reduce the cost by increasing the output of the machine of a given size. Increasing the speed is not practicable, at least not with such as blast-furnaces gases. The reliability of the machines would be lessened, not even considering the fact that the time available for the combustion of the mixture is too short and that, therefore, the losses on account of incomplete combustion would become too large. A comparison of the results of operation of gas-operated blowing engines, which run relatively slow, and engines driving dynamos, proves that the former require considerably less repairs than the latter.

The heat value of the mixture is also determined by the minimum excess of air necessary for complete combustion, and there remain only the two factors of volumetric and total efficiency. It is conceivable that the total efficiency might be increased by increasing the thermal efficiency of the process. This, however, is dependent upon increase of pressure and for this reason such a possibility must be eliminated. The volumetric efficiency can be increased in two ways: by cooling the charge and by increasing the pressure of the charge. The first method was proposed some time ago but has not been adopted because in most cases the cooling water is warmer than the atmosphere and the incoming gas. Besides, a large gain cannot be expected, as decreasing the temperature 10 deg. could only increase the output about 2 per cent.

The other method for increasing the output, which lately has attracted renewed interest, consists in increasing the pressure of the charge and simultaneous scavenging of the exhaust gases. In this manner a given suction volume of an engine can accommodate a larger weight of charge and greater output can be attained.

The original purpose of this method, which has been known in England for many years, was the avoidance of preignition by scavenging the cylinder of what remained of the hot exhaust gases. It is the competition into which the gas engine has lately had to enter with the steam turbine that has brought to the front the possibility of increased power output and lower cost.

The simplest method of realizing the scheme of scavenging and charging consists in closing the exhaust valve late and opening the inlet valve early. The time during which both valves are open is used for scavenging. To avoid loss of gas, the latter is admitted only after the exhaust valve is closed. At the end of the suction stroke the mixing chamber must be cleansed of combustible mixture by scavenging with pure air, as otherwise backfires would occur at the beginning of the next scavenging period. Gas and air are brought to the machine under a pressure of about 3 lb. per sq.in. gage. On account of this increased pressure the weight of the charge is about 20 per cent. greater than that of the normal method. Scavenging the combustion chamber also furnishes further space for fresh mixture. Experiments have shown a mean effective pressure of about 100 lb. per sq.in. In continuous operation mean effective pressure of 85 lb. per sq.in. can be reached.

In spite of the lower compression the heat consumption per unit of power is not increased. This is explained first by better combustion of the charge which is not contaminated by the remains of the exhaust gases, and secondly by a decreased percentage of loss in the cooling

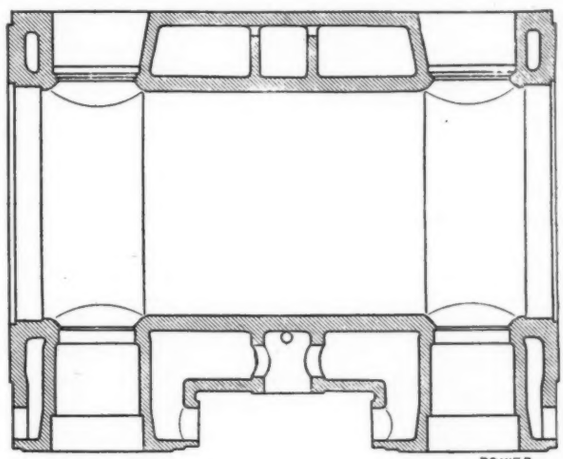


Fig. 4. One-Piece Gas-Engine Cylinder That Avoids Globe-Shaped Passages to Valves

water. The increased temperature of the cylinder walls has caused objections against continued operation with scavenging and forced charge, and some justification cannot be denied to these objections.

Improving Gas-Engine Economy

The desire of gas-engine builders to improve the economy of the gas engine, has lately brought to the front interest in the utilization of waste heat. The high temperature of the exhaust, about 880 deg. F., makes possible its use for the generation of steam in boilers, which have to be placed as closely as possible to the exhaust chamber. As a matter of fact, it is possible to obtain 2 lb. of high-pressure steam per kw.-hr. of the gas engine.

The utilization of the heat in the cooling water is not possible as directly as this. The further use of this heat means the generation of steam and this requires a considerably higher temperature than is customary in large gas engines. Semmler suggested, ten years ago, that gas-engine cylinders be cooled with water hotter than 212 deg. F., and that this water be put under pressure in order to avoid the generation of steam in the jacket. Evaporation commences only outside of the jacket, when the superheated water is conducted through a throttle valve into a steam drum. About a year ago it was decided at the Rombacher Huetten Werke to try Semmler's cooling method on an 800-kw. tandem engine. The results in operation, which are available today, are entirely favorable. The hot jacket not only did not hurt the cylinder, but it produced softer and more quiet operation.

REFRIGERATION DEPARTMENT

Relation of Cold Storage to Plant Capacity

The above is the title of an interesting paper read by John E. Starr at the seventh annual convention of the Eastern Ice Association, held in New York City from Nov. 6 to 8, inclusive. In the introduction the author discussed the monthly load or sales, pointing out the actual or probable distribution of the load throughout the year, and showing what storage capacity would be needed with a plant output considerably lower than the maximum demand. If only the general public is to be considered, and there are no unusual demands, such as fish or car icing, the average sale of ice year in and year out, and consequently the load on the plant for a decade, may be safely based on the mean monthly temperatures given by the U. S. Weather Bureau. If in the territory south of the fortieth parallel of latitude 32 is subtracted from the mean monthly temperature of each month, the resulting twelve numbers added together and the percentage of each number taken of the whole, the results will give very closely the percentage for each month of the total sale. In territory north of the fortieth parallel 30 is subtracted arbitrarily from the mean monthly temperatures and the percentages obtained in the same way. Using this method for any plant makes it possible to determine how much storage will be needed to run the plant almost continuously and store the surplus in the colder months. Two good examples of plants having the load line of New York City were cited by the author. Based on 32 years' average of mean monthly temperature, the distribution of sales or load on a plant having a capacity of 3100 tons in its maximum month figures about as given in Table 1.

TABLE 1. DIVISION OF LOAD ON 100-TON PLANT

	Per Cent.	Tons
January	2	364
February	2	364
March	3	546
April	5	920
May	8	1,456
June	15	2,710
July	17	3,100
August	17	3,100
September	14	2,548
October	8	1,456
November	6	1,096
December	3	540
Total		18,200

The table shows that in the months of January and February only 2 per cent. of the total annual output is sold, and the months of July and August have the maximum output of 3100 tons, which is 17 per cent. of the total. Multiplying 100 by 365 and dividing the total output, 18,200 tons, by this product, gives 49.8 per cent. as the annual load factor.

If instead of putting a 100-ton machine at work on a 49.8 per cent. load factor, a 50-ton machine were used on somewhere near an 100 per cent. load factor, and the surplus stored from January to May inclusive, the results shown in Table 2 could be obtained. The table is based on a refrigerated storage house having a capacity of about 5300 tons, and on the assumption that a machine making 50 tons in July and August would make about 55 tons in the winter months.

TABLE 2. A 50-TON MACHINE AND 5300-TON STORAGE FOR AN ANNUAL OUTPUT OF 18,200 TONS

	Sales Tons	Capacity Tons	Short	Stored
January	364	1,685		1,321
February	364	1,540		1,176
March	546	1,685		1,139
April	920	1,650		730
May	1,456	1,643		187
June	2,710	1,590	1,120	
July	3,100	1,550	1,550	
August	3,100	1,550	1,550	
September	2,548	1,550	998	
October	1,456	1,550		94
November	1,096	1,550		454
December	540	1,685		1,145
	18,200	19,228	5,218	6,246

The schedule in Table 2 allows for a shutdown of 20 days in the year, and, although this is feasible with a well built plant, an extra compressor might be considered by some as wise insurance. The necessary overhauling could be done in the early part of December.

Which of the two plants will pay better depends on the following factors: The cost of ground, the cost of buildings, the cost of equipment, the shop cost of ice, and the maintenance and replacement. This omits administration and officers' salaries, and confines the comparison to the total cost of ice delivered on the platform.

As a basis of what has been done, the author took a specimen year from the books of an ice factory having the New York load line. In this place the condensing water was a mixture of well water and city water averaging about 71 deg. The storage was for about 160 tons on end, and the sale 18,020 tons per year. The cost of coal was $2.85 per ton in the bunker. The plant was equipped with a compound engine and an auxiliary distilling apparatus. Table 3 gives the cost from the books for an average year.

TABLE 3. ACTUAL COST FROM BOOKS

		Cents per Ton
Coal	$5310	29.5
All labor, including repair labor	6420	35.6
Ammonia	270	1.5
City water	720	4.0
Repairs, material, oil, etc.	484	2.7
Total shop cost	$13,204	73.3

Mr. Starr did not know what had been done about an extraordinary repair fund and replacement, taxes and insurance, but assumed the charges given in Table 4 on the buildings, which cost $18,000, and the equipment costing $69,000.

TABLE 4. ASSUMED FIXED CHARGES

Buildings, 2 per cent.	$360
Reserve for extraordinary repair, accident and unusual loss of ammonia, 5 per cent.	3,150
Replacement, 6 per cent.	4,140
Taxes and insurance, 3 per cent. on $85,000	2,550
Assumed overhead 58.4c. per ton	$10,500
73.3c. per ton	13,204
$1.317	$23,704

The plant and the ground it was built on cost the owners $95,000. For the sake of comparison with the 50-ton plant and storage, selling the same amount of ice, a platform price of $2.50 per ton was assumed. Then, as the total output was 18,020 tons, the income for the year

would be $45,050. Deducting the operating and fixed charges of $23,704 leaves a gross profit of $21,346, which is 22.5 per cent. on the investment. Out of this, officers' salaries, office force and profits must be paid.

The nearest example to the 50-ton and storage plant, of which the author had actual figures from the books, was a plate plant operated by an absorption machine with water at 60 deg. F. and having a nominal capacity of 42 tons. The plant was operated for 330 days on a load factor of 91.5 per cent., and the actual ice made per year was 14,044 tons. The shop costs are given in Table 5.

TABLE 5. SHOP COSTS OF 42-TON ABSORPTION PLANT

		Cents per Ton
Coal	$3,315	23.6
Labor	4,978	35.45
Oil and waste	305	2.10
Ammonia (extraordinary)	1,877	13.37
Repairs (extraordinary)	1,602	11.40
	$12,077	85.92

The extraordinary ammonia and repair accounts of this year are abnormal, due to worn-out coils, which caused a great loss of ammonia. The replacement of these coils made the repair account up to the limit of what this item would be. The coal account is low, as steam for driving the auxiliaries was exhausted into the generator and little live steam was used. The water was 11 deg. colder than in the case of the 100-ton machine previously cited.

If the water had been at a temperature of 71 deg., as in the case given in Table 2, the cost of coal would have been greater, so to put the data on a comparative basis the data in Table 5 were modified. The cost of coal was made 30c. per ton of ice, instead of 23.6c. The ammonia and repair charges were reduced to a normal figure. With these modifications the results given in Table 6 were obtained. The cost of the equipment was $40,000, cost of buildings $11,000, cost of ice house $25,000, and cost of the ground $8000, making a total of $84,000. Table 7 gives the fixed charges, which amount to $7640. Adding to this the shop cost of $13,577, and the cost of handling and refrigerating 5200 tons of storage ice at 15c. per ton, amounting to $780, gives a total for the year of $21,997. Dividing by 18,200 gives a cost per ton of approximately 1.21c. Assuming, as before, a selling price of $2.50 per ton, the net income will amount to $45,500, and deducting the gross expense of $21,997, leaves $23,503 as the gross profit, which is 28 per cent. on the investment. Out of this profit, as before, must come administration and office charges.

TABLE 6. OPERATING COSTS OF 50- TO 55-TON MACHINE OPERATED AS IN TABLE 2 AND RUNNING 345 DAYS WITH ICE STORAGE OF 5200 TONS AND ANNUAL OUTPUT OF 18,200 TONS

		Cents per Ton
Fuel	$5,460	30
Labor	6,461	35.45
Oil and waste	382	2.10
Ammonia	728	4
Repairs, ordinary	546	3
Shop cost	$13,577	74.55

Summarizing on these two plants, the 100-ton machine without large storage, costing $95,000, yielded a gross annual profit of $21,346, exclusive of administration charges, or 22.5 per cent. on the investment. The 50-ton machine and large storage yielded $23,503 on an investment of $84,000, or 28 per cent. In these two cases the argument seems to be in favor of the small plant and storage, but it would not be safe to say that this would always be the case. The figures might be greatly modified by the cost of ground, the cost of the water supply and the character of the water. The cost of the coal in the two cases cited was not over $2.85 per ton, and there was an abundance of water which did not exceed 71 deg. F. in the hottest months. Depending on the location of the plant, the price of coal might easily vary from $1.30 to $4 per ton, and the temperature of the water from 60 to 85 deg. F. If coal was $4 per ton and water at 85 deg., it would mean that the fuel in the two plants just cited would cost 51.9c. per ton instead of 30 cents.

TABLE 7. FIXED CHARGES

Buildings—$36,000, 2 per cent.	$720
Extraordinary repair on $40,000, 5 per cent.	2000
Replacement on $40,000, 6 per cent.	2400
Taxes and insurance on $84,000, 3 per cent.	2520
Total	$7640

On the other hand, in a raw-water plant with a compound condensing engine and using 4 gal. of 59-deg. water per ton, with coal costing $3.05 per ton, 1740 tons of raw-water ice had been made with 127.5 tons of coal, costing $388. For water pumping, lighting, ice handling and taking care of the refrigeration of 4000 tons of ice, the cost was $90 more, making a total power cost for all purposes of $478. This averages a little over 27c. per ton for power alone for all purposes.

In the South, with oil at 90 to 95c. per bbl., and water at 78 to 80 deg. F., it costs from 80 to 90c. for fuel per ton of ice. The ordinary repair and extraordinary repair with warm water is also greater than with cold water.

It is thus apparent that the cost of production depends a great deal on the location of the plant, the water, and the cost of coal, so that the particular type of plant to install will largely depend on local conditions.

Cost of Power for Ice Making

It is not the writer's intention to take up the cause of the Brooklyn Edison, but instead to point out to Mr. Bigelow and those who have read his communication a fallacy in his argument. He states in part: " . . . it would be just as reasonable for the trolley companies and suburban railroad companies to insist that they should charge more for transportation during the rush period than they do during the nonrush hours." In the first place, trolley and railroad companies in their passenger divisions are not selling transportation, but transportation plus service. The class of cars, stations, waiting rooms, etc., furnished to passengers, as well as the extent or efficiency of porter service, information bureaus, etc., are factors entering into service and not into transportation. Furthermore, during rush hours the rates become automatically higher than during nonrush periods, for, although 5c. will normally pay rental for a seat in an urban conveyance between 10 and 11 a.m., it does not by any means insure the passengers even having a strap to cling to between 5 and 6 p.m.; nor would it be possible for public-service commissions or courts to require that the service at the two periods be entirely similar, if a flat rate were to be maintained.

During rush hours, or peak loads, on a telephone system, wires may be incessantly "busy," and on a telegraph system messages be sent in the order of their receipt or importance. The rate may be no higher for one period than the other when duration of conversation or cost per word is considered, but the cost of service is undeniably increased.

Fortunately, central stations cannot report to a customer that the lines or stations are "busy" during rush

hours, or in any way make a difference in the quality of the service rendered, but they can, and are entitled to, charge an adequate rate for the service.

He further states: "The practice of the central station is to charge anywhere from ½c. to as high as 15c. per kw.-hr. In almost every other business, such as transportation, communication, etc., such discriminatory rates have been shown to be illegal. Probably they will be so held in connection with light and power before long in many of the states." Mr. Bigelow might have to advantage omitted the word "such," for simply because a rate varies does not necessarily mean it is discriminatory. The government postal rates are 2c. an ounce for first-class matter, and 4 oz. for 1c. for second-class matter—a difference of 8:1. If this is discrimination it affects many more than merely "50 helpless small users" and Mr. Bigelow should lend every effort toward any movement which will stamp it out or at least lessen the difference between the two rates.

CECIL W. BROWN.

New London, Conn.

Direction of Flow in Brine Cooler

Mr. Hooper in his article on the "Direction of Flow in Brine Cooler" in the Nov. 11 issue is correct in his contention that the brine and ammonia should flow in opposite directions so as to bring the warm gas and brine at one end and the cold gas and cold brine at the other. Practically all ammonia and brine double-pipe coolers are arranged on the counter-flow principle, and I believe Mr. Hooper will find that he will obtain better results if the flow of brine were reversed.

It would also be better to use one pump for one machine and the other for the other, but so connected that in case of one pump going out of service the second could be used temporarily on both machines.

W. L. DURAND.

Brooklyn, N. Y.

In the shell type of brine cooler better results are sometimes obtained by allowing the brine to flow up instead of down through the cooler as is the general custom. If the cooler is so operated that superheated vapor leaves it, it is better to bring the warm brine in at the top, but when saturated and even wet vapor leaves the cooler, better results may be obtained by bringing the warm brine in at the bottom, for the following reasons:

To obtain a flow of liquid and vapor through the cooler, a pressure difference must exist in it. The vapor outlet being at the top, the pressure there must be less than at the bottom where the liquid enters, and, consequently, the temperature of the saturated vapor at the top is less than that of the boiling liquid. At about zero gage pressure the boiling point of the liquid ammonia is raised 1 deg. F. for an increase or decrease of less than ½ lb. in the suction pressure. Furthermore, a shell-type brine cooler, properly installed and constructed, will contain a considerable quantity of liquid ammonia, when in full operation, which still further increases the pressure difference between the top and the bottom of the cooler. When they are used in connection with absorption machines, it has been found best to bring the warm brine in at the bottom, in order to obtain a more active evaporation of the slightly impure anhydrous ammonia, which necessarily results from the operation of such a system, as it is impossible to remove all the water vapor brought over from the generator.

In this case I do not believe that the results will be bettered by a change in the direction of flow of brine, for the reasons above given.

If there is trouble in boiling off the liquid in the brine coolers, it is probably due to a considerable percentage of water being contained in the liquid. The boiling point of this mixture is higher than that of the pure liquid. This difficulty can be overcome by frequently purging the brine cooler and also by so adjusting the operation of the rectifier that the temperature of the ammonia vapor entering the condenser is not more than 10 deg. above the boiling point of the liquid ammonia at the condenser pressure.

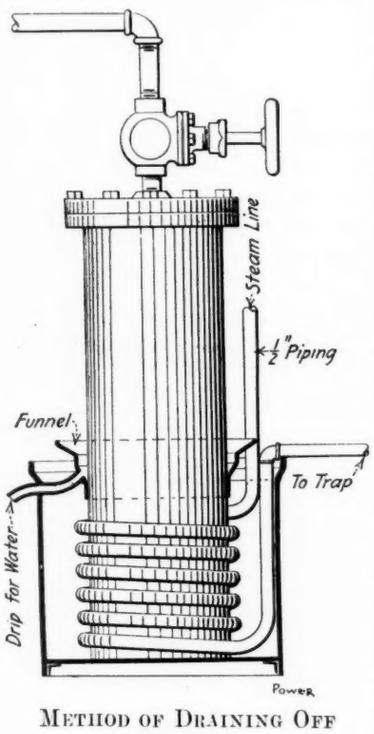
With regard to the operation of the brine coolers when operated in parallel with two brine pumps, it would be advisable to so cross-connect the pumps and coolers that either pump can be operated on either cooler, independently. It is difficult to so arrange the piping connecting the coolers and the pumps that the flow of brine is equally distributed between the two coolers, even though they may be of the same capacity and identical in construction.

FRED OPHULS.

New York City.

Preventing Corrosion of Ammonia Purifier

Our ammonia purifier only lasted four years. It was pitted so badly at the end of that time that it was not safe to use the cylinder any longer. A new one was ordered and a funnel was put around it even with the water line in the basin and a drip provided at the bottom of this funnel to drain off the moisture from the frost, etc. A ½-in. pipe was also wound around the bottom of the cylinder and the lower end run back up over the basin and connected to a trap. Then the basin was filled with oil. This arrangement has been operated for a year with no sign of deterioration. As will be apparent the coil is supplied with steam to heat the contents of the purifier and facilitate the process. Oil instead of water is used in the basin as it will not evaporate so readily.



METHOD OF DRAINING OFF MOISTURE

ALBERT WARNER.

Appleton, Wis.

EDITORIALS

Taking Pains in Designing

In no branch of engineering is accuracy of detail more important than in the design of power plants. The operating engineer knows to his sorrow that, unless complete working drawings are provided, the installation is certain either to give trouble when the construction force puts it together or to cost much more than it should.

In the extension of a plant, for example, it is hazardous to attempt to do the work without correct drawings of apparatus location, particularly where alterations in the situation of equipment enter the problem. Take the single matter of flue connections. Unless these are carefully designed, with due regard to expansion and contraction, inspection, subsequent accessibility for repairs and replacements, and, above all, to the elimination of leaks around joints and the minimizing of internal friction losses, either the cost of the completed work will be excessive or the plant efficiency will suffer. Extra plates and angles in breeching may not be expensive in themselves, but where they have to be used on account of poor fits or too little care in the making of preliminary measurements in the boiler room, they introduce eddies and back currents in the path of the gases going to the stack and cut down the draft accordingly.

It is an old definition of engineering to denote it as the art of making one dollar do the work of two, but there are still too many people of the opinion that money saved in cutting down preliminary drawings and measurements is real engineering economy. The power-plant operator well knows that much hard work with the tape and scale must be done in any job of planning to remodel an existing active installation for the production of steam or electric power. It may not be necessary to locate every pipe to the last inch, but unless the plans are prepared by somebody who knows just how much total space different sorts of piping and equipment demand, backed up by close personal investigation on the local site, the chances of misfits, exaggerated sizes in passages, cramped apparatus units, and inconvenient layouts of heavy pipe in places hard to reach are almost certain to result. In the past there has been too much reliance upon the general drawing, which covers a multitude of sins of omission, and too much reliance upon the abilities of the contractor along the lines of harmonizing equipment locations into one grand symphony of concordant operation.

Whether the plant owner realizes it or not, the task of altering a complex installation while keeping service intact is a man's job, and, to get the best results requires the united efforts of the man behind the throttle and the fellow on top of the drawing board. The concern which lets its operating staff in on the ground floor when betterments are planned and set in motion by the aid of outside advisers; which has the breadth of view to select the best ideas put forth, regardless of whether they come from the coal passer or from the head of the consulting firm; and which resists the temptation to hasten construction on the basis of insufficiently detailed drawings and specifications is the one which really conserves its resources and saves money in the long run.

Attention to Blowoff Valves

In this issue a contributor tells of how he was unable to close a blowoff valve he had opened to let water out of a priming boiler. A pocket knife, which had evidently been left in the shell, found its way to the blowoff pipe and, when the valve was opened, was carried into the valve and wedged there. As there was no blowoff cock or second valve on the line, the fire had to be drawn to prevent burning the shell after the water had drained out.

This case is only one of many similar near-accidents due to blowoff valves being held open by foreign substances, such as waste, nuts, pliers, parts of overalls, etc.

The pockets of overalls usually wear through quite quickly, owing to their being "worked at considerably above rating" as one might term it. Further, they are wide and too shallow, allowing such things as a pocket knife, small, flat monkey wrench, screwdriver, etc., which engineers usually carry, to easily fall out. With pockets filled with such things and the inevitable "bunch" of waste hanging half way out, it is not only possible but very probable that something will be "squeezed" out as the wearer wiggles himself through a manhole. If such things drop out as he enters the boiler, he will undoubtedly find them as he begins cleaning or inspecting.

Being cramped in a boiler is not conducive to comfort, especially if the dry pipe leaks, and one is always glad and anxious to get out. It is in the haste of getting out that things dropped from the pockets are likely to be left behind.

Another practice that has nothing to commend it is that of having the night watchman blow off the boilers before the engineer or fireman arrives.

The Gas-Engine Outlook

Many who listened to the discussion at the recent meeting of the Gas Power Section of the American Society of Mechanical Engineers doubtless detected beneath the apparent optimism of the remarks in general, a feeling of apprehension as to the future of the gas engine.

For many years this type of prime mover was handicapped by features of design, but these seem to have been successfully overcome. Another obstacle, with certain kinds of gas, has been the presence of tar; but with the more approved methods of cleaning and careful attention on the part of the operator this has been reduced to a minimum. The limitations now appear to be chiefly commercial and in spite of its high thermal efficiency, the gas engine has failed to meet the predictions of its most enthusiastic advocates.

In the small and medium sizes, although apparently holding its own, the gas engine is at a disadvantage com-

pared with the steam engine, where there is a demand for exhaust steam. Obviously, the solution lies in the successful utilization of the waste heat; that is, from the cooling water and the exhaust gases, but more particularly the latter. Little has been done in this country along this line, but the problem is now actively engaging the attention of European engineers and some progress has been reported.

For large powers, however, the steam turbine seems to be in undisputed possession of the field (exclusive of hydro-electric plants) and the gas engine, except for special service, such as in steel mills, occupies a position analogous to the large steam engine. In other words, its limitations as to size have been reached and the present demand in central-station practice is for large units and high speed.

The future of the internal-combustion engine for large powers apparently lies in the development of a successful gas turbine. A number have been built, but as yet have not reached the commercially successful stage. But when it is recalled that the evolution of the steam turbine occupied a long period of years, there is no occasion to become discouraged over the progress of the gas turbine.

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Mr. Pinchot's Views on the Hetch-Hetchy Grant

After ten years of controversy over the subject, the United States Senate passed the Hetch-Hetchy dam-site bill on Dec. 6. The bill was passed by the House of Representatives several months ago. At the time of going to press, however, it has not yet been signed by the President. It authorizes the city of San Francisco to acquire a new municipal water supply by building a dam in the Yosemite National Park, one hundred and sixty miles from the city, which will store the flood waters of the Tuolumne River. The dam will be three hundred and twenty-five feet high, and the reservoir created will be from seven to eight miles long and one to one and a half miles wide, with a capacity of seven hundred and fifty thousand acre-feet. This reservoir is expected to furnish the city with a water supply of four hundred million gallons a day, and it is estimated that it will cost the city seventy-seven million dollars to complete the project. At a special election a few months ago the people voted for a bond issue of forty-five million dollars to begin the work.

Army engineers estimate that the city will be able to generate one hundred and fifteen thousand horsepower as a byproduct of the water-works. The bill passed by Congress requires the city to make provision for allowing the full natural flow of the stream to be used for irrigation, and for furnishing electric light and power at low cost to irrigationists. San Francisco is to build roads into the Hetch-Hetchy Valley, which has been almost inaccessible, and around the lake to be created. Sale of water and electric current by the city, to other municipalities and to private users, is to be subject to regulation by the Department of the Interior, and the taxes exacted by the government will be governed by the quantity of electricity generated and the rates charged.

Although it was shown that less than three hundred people a year have visited the Hetch-Hetchy Valley, which is described as a swampy section at about three thousand feet elevation, hot and mosquito-infested, a group of nature lovers made a desperate fight against the passage of the bill, on the ground that the dam will desecrate and destroy the beauty of the valley. Thousands of dollars were spent by the nature lovers in a lobby fight against the legislation, and San Francisco people alleged that much larger sums were secretly spent in opposition to the measure by the private water and power companies which now monopolize the city's water supply, and largely monopolize the hydro-electric power on the Pacific coast.

The bill was approved by Franklin K. Lane, Secretary of the Interior; Secretary Houston, of the Department of Agriculture, and Frederick A. Newell, chief of the Reclamation Service. Gifford Pinchot, former chief forester of the United States, and the leader in the conservation movement, actively supported the passage of the measure. When interviewed by a representative of POWER, after the passage of the bill, Mr. Pinchot said:

"I regard the passage of the Hetch-Hetchy bill as a distinct victory for conservation and good government. Conservation means use of natural resources for the benefit of the greatest number; neither exploitation for the benefit of a few, nor the holding from use. San Francisco needs a better water supply and the Hetch-Hetchy is the best and by far the most economical supply available, and certainly water can be put to no higher use than for domestic purposes.

"If the natural beauty of this valley is at all injured by substituting a lake for the present swampy floor of the Hetch-Hetchy, it is, in my opinion, altogether unimportant as compared with the benefits to be derived from its use for a reservoir. If less beautiful, which I doubt, it will be far more accessible after San Francisco has built the roads required under the grant. It is not true that San Francisco has been given control of any important part of the Yosemite Park, and the grant will in no wise affect the beauties of the Yosemite Valley, which are far removed from Hetch-Hetchy."

"Much of the opposition to the Hetch-Hetchy bill, it is asserted, has had its root in the unwillingness of water power and transportation interests in and around San Francisco to see the city get possession of the large hydro-electric power it will be able to develop from the proposed dam. I believe the public welfare will be better served by use of the Hetch-Hetchy Valley—a use which will not destroy its beauty—rather than by keeping it untouched for the benefit of the very small number of comparatively well to do people to whom it has been accessible. The fight of the nature lovers has been for the esthetic enjoyment of less than 1 per cent. of the people against the daily comfort and happiness of 99 per cent. When they come to see the actual results of the grant, after the excitement of the contest is over, I am certain that they will be glad and not sorry that the bill was passed. They have made a very lively fight, and were fairly beaten, and as good citizens I feel confident they will accept their defeat without bitterness. In passing the bill, I believe Congress has acted wisely and well and in the interest of all the people."

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Those desiring the index of POWER for the second half of 1913 may send in their names at any time. The index will be ready to mail as soon as possible after the appearance of the last issue of the present volume.

READERS WITH SOMETHING TO SAY

Averaging Recording-Gage Records

Referring to the article by Lloyd W. Taylor published in POWER for Nov. 11, and relating to the averaging of recording-gage records, it is unfortunate for the casual reader that the author does not more clearly draw a distinction between methods and formulas which are exact in principle and those which are only approximate and which will of necessity involve an error which may be large or small depending on circumstances.

The method proposed by Mr. Taylor is fundamentally the same method which has been proposed by various writers and under various forms and depends on exactly the same principle as indeed must all methods which attempt to derive a mean polar ordinate by the use of the ordinary area planimeter.

These methods substitute the square root of a mean square for the simple mean, an assumption which is fundamentally in error. The magnitude of the error will depend on the character of the diagram and may be important or unimportant according to circumstances. The point of chief importance, however, is that when the reader of an engineering paper is given a rule or a method for doing something he should be told plainly whether the method is correct in principle or otherwise to the end that he may know exactly the sources and character of the errors liable to be encountered.

In the case of the method proposed by Mr. Taylor the procedure is simply a program for finding the radius of the circle whose area is equal to that of the actual diagram, and then expressing the equivalent of this radius in scale divisions. The central feature of the whole program is the determination of the radius and the use of this radius as the mean for the irregular diagram. This is exactly the use of the square root of a mean square instead of the true mean.

The procedure specified seems needlessly long and complicated. For those who may desire to use the ordinary planimeter the following method will be found the exact equivalent of Mr. Taylor's, requiring the use of no special table and only three steps, as follows:

1. Find with the common planimeter the area of the diagram in any convenient units, say, square inches.
2. Find by suitable procedure the value of r. This will be the radius (in inches) of the circle of equivalent area.
3. Lay off on the chart this distance as a radius from the center, and the point thus determined will give, according to the reading on the chart, the value sought. Or, if more convenient, from the radius found in (2) subtract the radius of the zero circle and lay off the remainder along a radial line from the zero circle. The result will be the same.

The common type of planimeter is exact in theory for finding areas and the only errors involved in its use are those due to instrumental imperfection and to personal error in manipulation. When the attempt is made to use the instrument for averaging radial ordinates there is of necessity added an error of theory or of fundamental principle, and this error, however disguised, is essentially that of taking the square root of a mean square instead of a true mean. Similarly the radial averaging instrument is exact in theory for finding the mean radius of a diagram drawn in polar coördinates, and the only errors involved in its use are those due to instrumental imperfection and to personal error in manipulation. If an attempt were made to use this instrument for the determination of area, there would be added a further error of theory or of fundamental principle.

If, then, the common planimeter is to be used for averaging polar diagrams it should be with a full recognition of the source and character of the error in principle which is involved, and it should not be so employed with the idea that the resultant errors will be limited to those which characterize its use for the determination of areas.

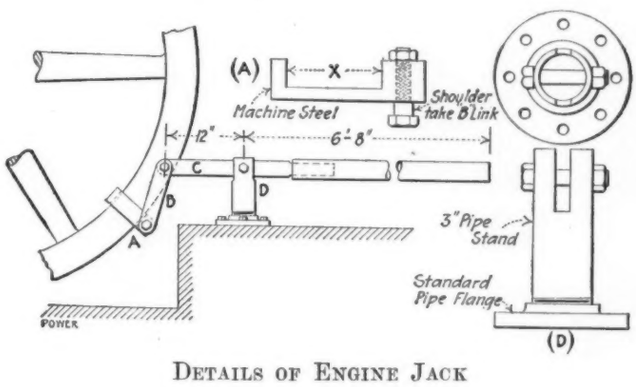
W. L. DURAND.

Brooklyn, N. Y.

A Simple Flywheel Jack

A few years ago the writer was serving as assistant engineer in a large power house and one of the daily bugbears was the turning over of a 500-hp. horizontal tandem steam engine. The difficulty was finally overcome by making the simple flywheel jack shown in the accompanying sketches.

The part A is of machine steel and should have its inner faces well cut, similar to a file so it will take a good "bite" on the flywheel rim. A few general dimensions



DETAILS OF ENGINE JACK

are suggested in the drawings, but these will vary with the size of the engine to be turned over. This flywheel was a ponderous affair, but the jack turned it over easily. The main lever may be of wood. We used a piece of 2-in. steam pipe. The jack parts A, B, C and D were made up in the machine and forge shops.

In operation the action of lifting up on the long lever automatically lets the clutch shoe A drop down for another hold on the flywheel rim. The inside span of the shoe A, as the dimension X, should be about $\frac{3}{8}$ in. more than the thickness of the rim, for a large rim. For

smaller rims, say, about 2 in. thick, the dimension X may be about ¼ in. greater than the rim depth. The standard D is made of a short length of 3-in. pipe.

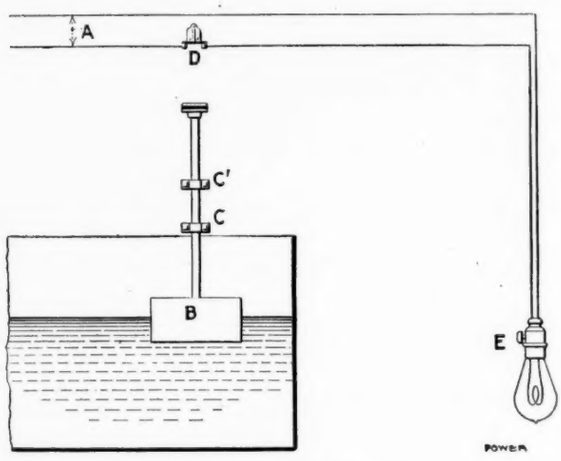
H. W. Secor.

New York City.

Another Water-Level Indicator

A simple and reliable water-level indicator is here shown. When the reserve or supply tank is located where it is not visible from the pump house, some method should be used to indicate the height of water in the tank.

The indicator herewith illustrated will show when the tank is full. Branch wires A from an ordinary lighting



Water-Level Indicator

circuit are run to the tank and continued to the pump house, or to several stations if required. A copper float B is attached to a rod, the top of which has a brass plate. The rod should be insulated from the plate and guided by clamps C and C^1. When the tank fills the rod will close the lighting circuit by bridging the space at D and the lamp E will light. By attaching an arm to the float rod it can be arranged to also show when the tank is empty by taking a couple of drop wires from the line A on the lamp side and arranging a break like D near the upper strap or guide.

James E. Noble.

Toronto, Ont., Can.

Buckling of Boiler Tubes

I read with interest the discussions under this title which have appeared in Power during the last few months and have studied the subject and made observations thereon.

I believe that the upward buckling of tubes in horizontally baffled water-tube boilers is due, primarily, to the fact that nearly all the heat absorbed by the water in passing through a tube is taken from the lower half, thus keeping this part cooler and shorter than the upper half. This conclusion is supported by the following facts:

The upper part of the tube is in contact with a mixture of steam and water, which is a poor conductor of heat. The bottom of the tube is in contact with water. The efficiency of heating a liquid, as water, by convection is immensely greater than that of heating a mixture of vapor and water by conduction.

Therefore, since the lower part of the tube offers the more efficient avenue of escape for the heat, it follows that the rate of heat transfer therefrom is much greater than from the upper part and it is, consequently, at a lower temperature. Much of the heat absorbed by the top of the tube is conducted toward the bottom before it enters the water.

I measured the deformation of the tubes in three 150-hp. horizontally baffled boilers and found that in all the tubes were buckled upward, that the buckling was greatest in the lower row, that the middle tubes of each row were buckled more than the outer ones and that the tops of the bends in the lower row were about 4½ ft. from the front water leg.

That the middle tubes were the most buckled may be explained by the fact that, they being directly under the steam drum, the circulation was more direct and better than in the outer tubes and that the better the circulation the greater the rate of heat transfer from the bottom of the tube and the greater the temperature difference between the top and bottom. Also, the gases are probably hotter away from the walls of the setting.

That the lower row buckles most may be due to the radiation from the fire heating the baffle tile, which conducts the heat to the top of the tube.

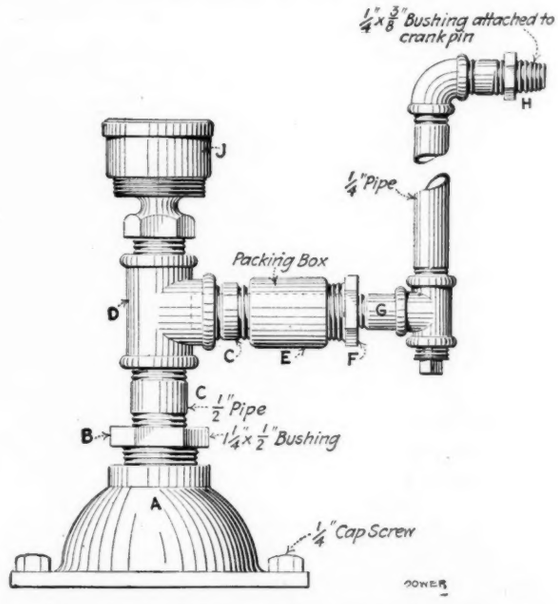
In vertically baffled boilers the heat flow from the furnace gases into the water is much more complex than in horizontally baffled boilers, therefore, its effect in deforming the tube may also be expected to be more complex.

Keller Shank.

Fort Wint, P. I.

Grease Cup for Crankpin

In our plant we have a 12x12-in. engine running 150 r.p.m. and driving a 70-kw. generator furnishing current for motors driving centrifugal pumps and for lighting. As this engine sometimes has to run 12 hr. without a stop and as we had only a common grease cup on the crank



Grease Cup for Lubricating Crankpin

which was impossible to fill when the engine was running, I made the device shown, which is simple and gives good satisfaction as the grease cup is stationary.

In the drawing, *A* is a foot flange for 1¼-in. pipe used for fastening railings to the floor. A ½x1¼-in. bushing *B*, ½-in. nipples *C* and *C'*, and a ½-in. tee *D* are used. The ½-in. coupling forms the stuffing-box, the end of the nipple *C'* making the bottom against which the packing rests. The bushing *F* forms the gland, which is ½x⅜ in. The ¼-in. pipe *G* slips inside the bushing and is threaded on one end only, the other end turning in the stuffing-box. All the other fittings shown are ¼ in., except the bushing *H* and the cup *J*.

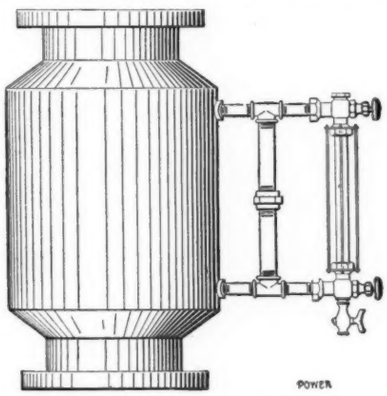
PERRY BARTRAM.

Cedar Point, Ill.

Preserving Separator Gage-Glasses

Nearly every engineer knows that it is difficult to keep the glass gages in steam separators from breaking.

Many causes for the breakage of these glasses are assigned, but my theory is that the changing velocities of the steam flowing through the separator is principally



CIRCULATING PIPE TO PREVENT BREAKING OF SEPARATOR GAGE GLASS

accountable for the breakage of the gage-glasses. These velocity changes occur so rapidly as to create a partial vacuum in the glass on account of its small area. Though it lasts only for an instant, the temperature is reduced sufficiently to produce a cracked glass. Perhaps one or a number of the changes would not break the glass, but a number of them occurring continuously, especially as often particles of water adhere to the sides of the glass, cause the glass to break.

The pipe at the side of the glass in the illustration allows for enough additional circulation to nullify the conditions referred to above, and leave the temperature of the glass somewhat constant.

W. OLIVER.

Bethlehem, Penn.

Pocket Knife in Blowoff Valve

Upon entering the boiler room I noticed an unusually high-water level in one of the boilers. As I had had trouble with the boilers priming, due to the heavy load on them, it was necessary to keep the water as low as possible, so I proceeded to open the blowoff valve, but I was unable to close it when the water fell to the proper level. The fire was pulled and the boiler cut off from the line, after which I examined the valve to learn the cause of the trouble. The valve referred to is an angle valve, and I found a pocket knife lodged between the valve and its seat.

There are two lessons to be learned from this little incident, the first is that we should be very careful to leave nothing in the boiler that can enter the blowoff pipe when washing out, second, that there should be two valves in the blowoff pipe, so if one fails the other can be put into service. This incident took place in an ice plant and I was obliged to shut down one of the ice machines while the boiler was being put back in service. A shutdown of three or four hours means much in an ice plant, especially in the busy season.

E. O. HAMILL.

Salem, Ohio.

Linseed Oil for Hot Journal

Troubled with a hot crankpin, I tried all of the customary methods with but little success. Noticing a can of boiled linseed oil on the engine-room floor, I tried some with surprising results. Since that I have found that applications of boiled linseed oil alternately with a 1 to 1 mixture of engine and cylinder oil have given the best results in cooling hot journals.

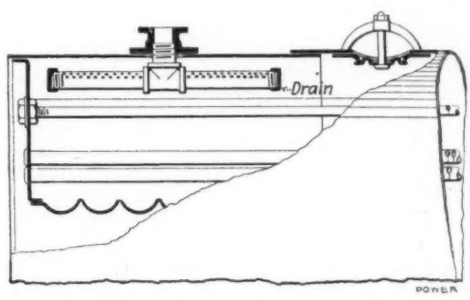
JAMES BEGGS.

Montreal, Can.

Drains for Dry Pipe

Recently I recommended a dry pipe made as illustrated to be placed inside a steam boiler to prevent priming, and suggested that a small hole be drilled on the under side of each end to prevent an accumulation of water while the boiler was standing idle. The total area of the small holes in the dry pipe should equal to double the area of the steam pipe.

The engineer in charge when the pipe was being installed advised that the drain holes be plugged. He maintained that they were an unnecessary precaution and that they affected the efficiency of the device, arguing that



SHOWING LOCATION OF DRAIN

as soon as the boiler began to steam any water in the dry pipe would absorb the latent heat in the steam and evaporate, so that before the boiler was ready to be cut in, the dry pipe would contain steam only.

Engineers seem to differ regarding this and I think it a good topic for discussion.

BURT N. EVERETT.

Jamestown, N. Y.

ENGINEERS' STUDY COURSE

Trigonometry—V

LAST LESSON'S ANSWERS

16. From equation 11 (last lesson)

$$\sin 75° = \sin 30° \times \cos 45° + \cos 30° \times \sin 45°$$

Given $\sin 30° = \frac{1}{2}$ then, by equation 1 (Lesson III) and as worked out in answer 14 (Lesson IV) $\cos 30° = \frac{\sqrt{3}}{2}$. Also, given $\sin 45° = \sqrt{\frac{1}{2}}$, then, as explained in answer 15, $\cos 45° = \sqrt{\frac{1}{2}}$.

Now, substituting in the above equation

$$\sin 75° = \tfrac{1}{2} \times \sqrt{\tfrac{1}{2}} + \frac{\sqrt{3}}{2} \times \sqrt{\tfrac{1}{2}} = \frac{1}{2\sqrt{2}} + \frac{\sqrt{3}}{2\sqrt{2}}$$

$$= \frac{1 + \sqrt{3}}{2\sqrt{2}} = 0.9659$$

Note that this agrees with the value given in the table in Lesson II.

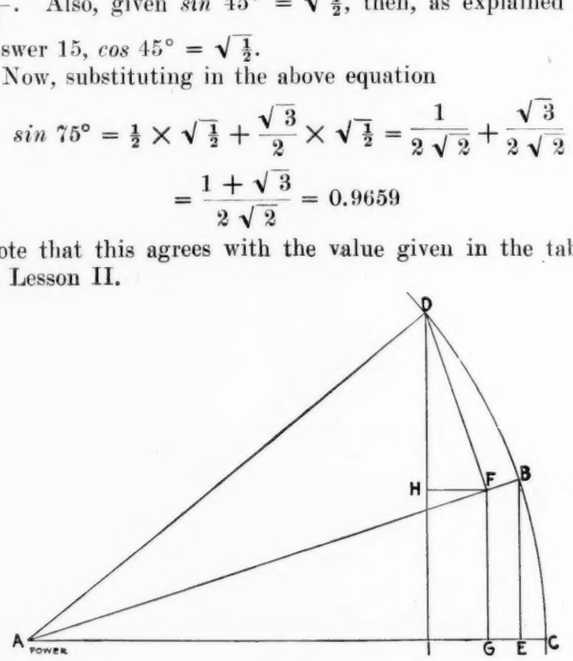


FIG. 6.

17. From equation 12,

$$\sin 15° = \sin 45° \times \cos 30° - \cos 45° \times \sin 30°$$

substituting the values

$$\sin 15° = \sqrt{\tfrac{1}{2}} \times \frac{\sqrt{3}}{2} - \sqrt{\tfrac{1}{2}} \times \tfrac{1}{2} = \frac{\sqrt{3}}{2\sqrt{2}} - \frac{1}{2\sqrt{2}}$$

$$= \frac{\sqrt{3} - 1}{2\sqrt{2}} = 0.2588$$

which also agrees with the value given in the table.

18. Required an expression for $\sin (A + B) + \sin (A - B)$. Substituting their values as given in equations 11 and 12

$$\sin (A + B) + \sin (A - B) = (\sin A \cos B + \cos A \sin B) + (\sin A \cos B - \cos A \sin B)$$

Simplifying

$$\sin (A + B) + \sin (A - B) = 2 \sin A \cos B$$

19. Referring to Fig. 6, let angles CAB and BAD represent any two angles A and B, as in the derivation of equation 11. It is required to find an expression for $\cos (A + B)$, which is AI in Fig. 6.

Evidently

$$AI = AG - IG$$

or, since

$$IG = HF$$

$$AI = AG - HF$$

By similar triangles

$$\frac{AG}{AE} = \frac{AF}{AB}$$

$$AG = \frac{AE \times AF}{AB} = \frac{\cos A \cos B}{1}$$

Also, by similar triangles

$$\frac{HF}{BE} = \frac{DF}{AB}$$

$$HF = \frac{BE \times DF}{AB} = \frac{\sin A \sin B}{1}$$

Substituting in the equation for AI

$$\cos (A + B) = \cos A \cos B - \sin A \sin B \qquad (13)$$

Another demonstration may be made directly from equation 12. Since A is any angle, the complement of any angle may be substituted, as $90° - A$. Putting this in equation 12 gives

$$\sin (90° - A - B) = \sin (90° - A) \cos B - \cos (90° - A) \sin B$$

But $90° - A - B = 90° - (A + B)$ and $\sin [90° - (A + B)]$ = the sine of the complement of $(A + B)$ or $\cos (A + B)$. Also $\sin (90° - A) = \cos A$ and $\cos (90° - A) = \sin A$. Substituting then in the above equation it reduces to the form of equation 13.

20. As in the derivation of equation 12, now let angle A be represented by angle CAD, Fig. 6, and angle B by angle CAB. Again,

$$AG - IG = AI$$

or, since $IG = HF$

$$AG - HF = AI = \cos A$$

By similar triangles, as before,

$$AG = \frac{AE \times AF}{AB}$$

which, with the present angles, means

$$AG = \cos B \cos (A - B)$$

Also by similar triangles

$$\frac{HF}{BE} = \frac{DH}{AE}$$

$$HF = \frac{BE \times DH}{AE} = \frac{\sin B \times DH}{\cos B}$$

but

$$DH = DI - HI = DI - FG = \sin A - FG$$

and by similar triangles again

$$\frac{FG}{BE} = \frac{AF}{AB}$$

$$FG = \frac{BE \times AF}{AB} = \sin B \cos (A - B)$$

then

$$DH = \sin A - \sin B \cos (A - B)$$

and

$$HF = \frac{sin\ B\ [sin\ A - sin\ B\ cos\ (A - B)]}{cos\ B}$$

Now substituting the values of AG and HF in the equation that equals $cos\ A$

$$cos\ B\ cos\ (A - B) - \frac{sin\ B\ [sin\ A - sin\ B\ cos\ (A - B)]}{cos\ B} = cos\ A$$

Multiplying through by $cos\ B$ to eliminate the fraction

$$cos^2\ B\ cos\ (A - B) - sin\ A\ sin\ B + sin^2\ B\ cos\ (A - B) = cos\ A\ cos\ B$$

or

$$(cos^2\ B + sin^2\ B)\ cos\ (A - B) = sin\ A\ sin\ B + cos\ A\ cos\ B$$

or, since $cos^2\ B + sin^2\ B = 1$

$$cos\ (A - B) = sin\ A\ sin\ B + cos\ A\ cos\ A \qquad (14)$$

Functions of the Sum and Difference of Angles Continued

Having now studied the sines and cosines of the sums and differences of two angles it will be sufficient to further consider only the tangents and cotangents. It is to be proved that *the tangent of the sum of two angles is equal to the sum of their tangents, divided by 1 minus the product of their tangents.*

As the tangent of any angle is equal to its sine divided by its cosine,

$$tan\ (A + B) = \frac{sin\ (A + B)}{cos\ (A + B)}$$

Therefore, from equations 11 and 13

$$tan\ (A + B) = \frac{sin\ A\ cos\ B + cos\ A\ sin\ B}{cos\ A\ cos\ B - sin\ A\ sin\ B}$$

Dividing the numerator and denominator of the second term by $cos\ A\ cos\ B$

$$tan\ (A + B) = \frac{\frac{sin\ A}{cos\ A}\frac{cos\ B}{cos\ B} + \frac{cos\ A\ sin\ B}{cos\ A\ cos\ B}}{\frac{cos\ A\ cos\ B}{cos\ A\ cos\ B} - \frac{sin\ A\ sin\ B}{cos\ A\ cos\ B}}$$

Canceling

$$tan\ (A + B) = \frac{\frac{sin\ A}{cos\ A} + \frac{sin\ B}{cos\ B}}{1 - \frac{sin\ A}{cos\ A} \times \frac{sin\ B}{cos\ B}}$$

and, again, the sine divided by the cosine of an angle being equal to its tangent,

$$tan\ (A + B) = \frac{tan\ A + tan\ B}{1 - tan\ A\ tan\ B} \qquad (15)$$

Next to prove that *the tangent of the difference of two angles is equal to the difference of their tangents, divided by 1 plus the product of their tangents.*

The demonstration is precisely similar to the last except that equations 12 and 14 are used, showing that

$$tan\ (A - B) = \frac{sin\ (A - B)}{cos\ (A - B)} = \frac{sin\ A\ cos\ B - cos\ A\ sin\ B}{sin\ A\ sin\ B + cos\ A\ cos\ B}$$

Again, dividing the numerator and the denominator of the last term by $cos\ A\ cos\ B$

$$tan\ (A - B) = \frac{\frac{sin\ A\ cos\ B}{cos\ A\ cos\ B} - \frac{cos\ A\ sin\ B}{cos\ A\ cos\ B}}{\frac{sin\ A\ sin\ B}{cos\ A\ cos\ B} + \frac{cos\ A\ cos\ B}{cos\ A\ cos\ B}}$$

which, by cancellation and the substitution of the tangent for the sine divided by the cosine, reduces to

$$tan\ (A - B) = \frac{tan\ A - tan\ B}{1 + tan\ A\ tan\ B} \qquad (16)$$

Study Questions

21. Show that *the cotangent of the sum of two angles is equal to the product of their cotangents minus 1, divided by the sum of their cotangents.*

22. Show that *the cotangent of the difference of two angles is equal to the product of their cotangents plus 1, divided by the difference of their cotangents.*

23. Given $tan\ 30° = \frac{1}{\sqrt{3}}$ and $cot\ 45° = 1$, find $tan\ 75°$.

24. Given the same, find $cot\ 15°$.

25. Deduce an expression for the tangent of the sum of two angles minus the tangent of their difference.

❖

Johns Hopkins to Teach Engineering

The Johns Hopkins University has established a department of engineering made possible by a large appropriation from the state of Maryland. The state, however, exercises no control over the institution.

The new buildings now under construction are designed to offer complete facilities for graduate work in engineering, and the department aims to carry on research work in various branches of engineering. Undergraduate courses preparing students have been planned to afford opportunity for unusually thorough training. Courses have been established in civil, electrical and mechanical engineering under the direction of Prof. C. J. Tilden, formerly head of the department of engineering mechanics, University of Michigan; Dr. John B. Whitehead, formerly professor of applied electricity, Johns Hopkins University, and Prof. Carl C. Thomas, formerly head of the department of mechanical engineering, University of Wisconsin.

The engineering students will not begin to specialize until the beginning of the fourth year's work, though there will be minor exceptions to this rule. In the third year three parallel courses will be taken by all engineering graduates dealing with the broad outlines of civil, mechanical and electrical engineering. Drawing and engineering design are continued through the entire undergraduate period and laboratory and surveying courses form part of the first three years' work. In the fourth year specialization begins, but the course has been planned to avoid early specialization and of affording the student thorough fundamental preparatory training.

Those entering the undergraduate courses must have a satisfactory knowledge of mathematics, English, history, French or German, Latin (or physics and manual training); a science, such as botany, chemistry or biology; mechanical drawing. Before being admitted to the examinations, the applicant must show that he has completed courses equivalent to a four-year high-school course in these subjects.

A bachelor's degree will be given upon the completion of four years of undergraduate work. The departments of engineering will not include machine shop, foundry, etc., although some equipment will be used for illustrating manufacturing processes as part of the laboratory work. Each undergraduate student must spend at least four months in a shop or drawing office during his course, and will be advised to spend a year, if possible, in addition to attending surveying classes in the field for about five weeks during one of the summer vacations. It is expected that the undergraduate courses thus given will lead to the use of the exceptional facilities which have been provided for graduate work.

This fall 75 undergraduates and 15 graduate students have entered the engineering department. The new building will be ready for occupancy at the beginning of the college year 1914-15.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

MERRY CHRISTMAS—EVERYDODY!

A Merry Christmas to you, and yours! The merry day is here once more, son. We know it; oh! we know it, just as the first glimmer of daylight peeps from behind our bedroom curtains and we hear the soft patter of tiny feet in the hallway. Then the door bursts open and in comes our white-robed brood of little tots. They climb up on the bed and bang our bald head with a woolly lamb or a whole train of tin cars and cry: "Merry Christmas, daddy and mama; see what Santy give us!" Christmas? You bet!

Or perhaps it's our son's or daughter's kiddies who greet us on this happy morning, and we begin to wonder in sleepy fashion if the years have flown thus quickly. And we say so to the missis, while the chatter and the prattle of the little kiddies goes on— It just makes us think, doesn't it?

Of course, there are young chaps we know who are single, and know not the joys and thrills of happy fatherhood; whose lives lack the sunshine and the companionship of the real home. And they won't know, either, until they have sought out that one Her who is waiting for that Him to make the next Christmas a real one for them both.

Christmas means a lot to you and to me, and we are hoping the whole world has a share in our happiness—at the least, we are trying to feel that way, aren't we, son?

So, with Dickens' Tiny Tim we say: "God bless us, every one!" and a merry and joyous Christmas to everybody!

❖

One of the two Latin quotations we know is "Caveat emptor."—Let the buyer beware. It is again called to mind by its use in an electrical central-station monthly. It's a corking good suggestion to all parties concerned, even from the consumer's point of view.

❖

We wonder if it is one on the efficiency engineers, when a concern in New York "goes broke" trying to cut expense for others? This happened a short time ago to a concern that ended up with liabilities of $75,000 and assets of $30,000.—"Graphite."

This column is regularly dixoned with a "No. 1-151," brother, which refuses to turn against its maker, but— Is the above a slam or just airy persiflage?

❖

There were and are quite a few prominent "noncollege" men when you come to dig them up—figuratively speaking. Herb Spencer at 26 was a locomotive engineer; how Charley Darwin got his, we know not, but he was a "non"; the first time Vambrey went to college he went to teach, and he spoke and wrote 12 Asiatic and nine European languages; Lowell told Howells he could be glad he was a "non"—might have lost his originality and become imitative; Jack London could have, but he thought a college training was narrow; good old Elihu Burritt, at 30, had mastered 50 languages, and "his student's lamp was a forge and his desk an anvil."

❖

"The engineer was taking his train to New York when the locomotive steam-chest exploded, drenching him with steam and boiling water. He stuck to his post and applied the brakes. When found he was unconscious, with his hand on the throttle."—Daily Paper.

Would ask how this paper thinks the engineer reached that steam chest from the cab. Perhaps the cylinder valve on the mud drum of the cowcatcher corroded and let the vacuum leak over onto the bell rope. Mebbe, while standing on a siding the locomotive chest was bitten through by a man-eating goldfish! Who knows?

❖

Friend Horton, of Chattanooga, is hereby thanked for the dope on this rural happening in Tennessee: Business of alarmed villagers; locomotive whistle blowing to beat the band; more business of alarmed yokels; whistle still blasting; fire, flood and pestilence predicted; engine, closely accompanied by whistle, winds its tortuous way down the dew-kissed valley to village; whistle still most continuous; engine disappears kerflop! and all is silence. Business of local paper trying to explain: "Whistle valve was caught open with engineer powerless. As the huge machine passes, two men are observed firing, which indicates that the whistle is exhausting the steam needed to propel the engine." Some whistle!

NEW PUBLICATIONS

HANDBOOK FOR MACHINE DESIGNERS AND DRAFTSMEN—By F. A. Halsey. 494 8½x11-in. pages; 120 charts and diagrams and over 400 other illustrations; 400 tables; semiflexible cloth binding. Price, $5, net. McGraw-Hill Book Co., New York, N. Y.

In his able review of Mr. Halsey's book, which we give in abstract, Prof. Dexter S. Kimball, of Sibley College says:: Every man who has had experience in designing machinery has felt the daily need of a comprehensive reference book to which he could turn either to refresh his memory on basic principles or to find help and guidance from the experience of others. The ordinary text pocket-books satisfy this need only imperfectly, but it has been answered fully in Mr. Halsey's "Handbook for Machine Designers and Draftsmen." No man, in America at least, has had such an opportunity as Mr. Halsey has had for the last 30 years, to come in close touch with the best current literature of this subject, and few possess his experience and the discriminating judgment so necessary to select from this vast collection that which will be most reliable and helpful to the designer. To this carefully selected data Mr. Halsey has added the results of his own unequaled experience and he has supplemented the whole structure with valuable aid from experts in the several branches. Naturally he has drawn upon the files of the "American Machinist" for the greater part of the collected data which he presents, partly because of his long connection with that magazine, but chiefly because it contains the best in current literature on this subject for the last 25 years. The book is, therefore very complete and eminently useful.

It is difficult to make comparisons between this book and others since it is quite different in its makeup from most books on design, but the following list of the divisions of the work will give some idea of the scope of the treatise.

MECHANICAL PRINCIPLES OF DESIGN—This chapter presents some of the more general features of correct construction for which such masters as Prof. Sweet and John Richards have so long contended.

PLANE AND SLIDING BEARINGS—The tables of allowable bearing pressures given are probably the most complete ever presented. The discussion of the relation between pressure, speed and temperature is clear and concludes with valuable diagrams for the design of bearings for perfect film lubrication. The question of proper bearing materials is fully discussed and the chapter is concluded with valuable data on bearing design from the practice of such concerns as the General Electric and the Westinghouse Electric companies, as well as data on thrust bearings.

SHAFTS AND KEYS—In addition to the usual formulas for the strength and stiffness of shafting the chapter contains a number of useful charts for applying these formulas, not only to solid shafting, but to the hollow forms also. The critical speed of shafting is fully discussed. New data on the friction of shafting are given and a subsection on keys and keyways.

BELTS AND PULLEYS—This chapter contains not only the latest theory and practice on belt driving with practical data bearing thereon, but contains much useful information on laying out belt drives, data on cast-iron pulleys and deductions for the strength of cast-iron pulleys from Prof. Benjamin's experiments.

FLYWHEELS—The most uptodate treatment of the strength of flywheels and typical designs suitable for various kinds of service.

CONE PULLEYS AND BACK GEARS—This chapter includes graphical methods as well as the usual algebraic formulas for belt lengths and also discussess the methods for obtaining geometric progression of speeds.

GEARING—Voluminous tables of tooth parts and odontographic methods are given. Full discussion of the strength of gear teeth and an excellent chart based on Lewis' work are also included; two most interesting and useful charts for reducing bevel gears to equivalent spur gears are to be specially noted. The author has also given his own well known contributions to the theory and practice of worm gearing. The treatment of spiral gearing is particularly good, and there is also a clear exposition of epicycle, or planetary gears as these are usually called.

ROPES—A complete exposition of rope and rope driving.

CHAINS—Valuable material on the new types of chains for power transmission much of which has been prepared specially by the Morse Chain Co. and the Link-Belt Co.

BRAKES AND FRICTION CLUTCHES—There is very little reliable information on this class of machinery to be had in

collected form and these sections are a valuable addition to the literature of the subject.

PIPES AND PIPE JOINTS—Complete tables of all kinds of standard pipes and pipe fittings, the usual formulas for design, and in addition the work of Professors Stewart and Carman, which is the latest information on pipes under external pressure, and which has not as yet found its way into all the literature of this subject.

HEAT—This section contains complete conversion tables between Fahrenheit and Centigrade scales, data on heat transference, etc.

STEAM BOILERS, THE STEAM ENGINE, THE GAS ENGINE—These three chapters treat these subjects not from the thermo-dynamic standpoint, but as structures or machines from the view of the designer. The data from current practice are especially comprehensive and valuable.

COMPRESSED AIR—A very complete exposition of the theory and practice of air compression with valuable diagrams and practical constructions. A noticeable feature is the clear discussion of the air-lift pump, data on which are rare.

Other chapters are devoted to ball and roller bearings, cams, springs, bolts, nuts and screws, wire and sheet-metal gages, hydraulic machinery, minor machine parts, pieces and running fits, balancing machine parts, miscellaneous mechanism, power requirements of tools, cast iron, steel, alloys, weights and materials, mechanics, strength of machine parts, weights and measures, and mathematical tables.

The book is printed on a large-sized page, the size of the type page being 7x9½ in. This is advantageous in that the book will lie open readily upon the desk and it allows ample space for large-sized charts. These charts and diagrams form one of the important features of the book. Many of the illustrations and tables are not to be found elsewhere. The presswork is most excellent, the work on the charts and diagrams being particularly good.

National Gas Engine Association Convention

The annual convention of the National Gas Engine Association was held December 4, 5 and 6, at the Boody Hotel, Toledo, Ohio. After an address of welcome by Mayor Brand Whitlock and response by Mr. Otto M. Knoblock on behalf of the association, the first day was devoted to hearing reports of the officers and various standing committees. These showed that the association had enjoyed a substantial growth during the year, that the financial condition was unusually satisfactory and that the activities and influence of the association had been much increased during the year by the employment of a paid secretary who devotes all his time to the association business.

PROFESSIONAL PAPERS

The first formal paper was presented Friday morning by L. M. Ellis, of Ann Arbor, Mich., who presented "The Elements of a Successful Cost Accounting System." Mr. Ellis treated the matter from a very practical standpoint and especially urged that costs of production be entirely separated from selling costs so that a good factory organization might not be unjustly blamed for losses caused entirely without the production department, as for instance a disastrous advertising policy. He stated that ninety per cent. of all business enterprises fail in less than fifteen years; lack of capital, primitive management, unfair competition and old age being the usual causes of failure. His classification of the basic talents of men as leadership, making, teaching, trading and organizing was unique and led to the conclusion that as all these talents are seldom possessed by one man and are all necessary in a modern business, a one-man business is likely to be a failure.

In discussing different systems he stated that over half of the cost systems installed failed and were discarded within a year and emphasized the fact that a lot of printed blanks, however cleverly gotten up, did not constitute a cost accounting system, but that any system was bound to fail which is not a simple, commonsense, workable plan which can be put through without change of personnel.

Two hours of spirited discussion followed Mr. Ellis' paper during which it was pointed out that frequently such cost items as depreciation of plant, interest on investment, development costs and improvement of output were frequently overlooked by manufacturers in figuring production expenses, with the result that the market is demoralized by engines sold below actual cost.

In a paper, "Springs as Related to the Gas Engine," F. E. Whittlesey called attention to the necessity of properly providing for the necessary springs in gas engine design so that they may be of ample size and cool at all times. He also cited tests to show that vanadium steel springs gave fully twice the service of carbon steel springs of the same design.

"Standardization," by Joseph A. Anglada was presented by A. E. Potter in the absence of Mr. Anglada. The paper gave some of the results accomplished in the standardization of parts by other societies, outlined the necessary steps for the Gas Engine Association to take to begin the work and suggested some of the points where the work along this line might well start.

The principal entertainment features of the convention were a smoker tendered by the Maumee River Yacht Club on Thursday evening, luncheon with the Toledo Chamber of Commerce Friday noon and the annual banquet Friday evening at which short talks were given by Paul Regan, of Toledo, H. W. Jones, Chicago, Prof. W. T. Magruder, Ohio State University, Prof. G. W. Munro, Purdue University and others, H. W. Bowlens, Port Washington, Wis., acting as toastmaster.

Three members of the executive committee were elected, E. J. Perkins, St. Joseph, Mich., H. D. Lauson, New Holstein, Wis., and H. G. Diefendorf, Detroit, Mich., being chosen. The officers for the ensuing year are: R. A. Oglesby, South Bend, Ind., president, H. D. Lauson, New Holstein, Wis., vice-president; O. M. Knoblock, South Bend, Ind., treasurer and H. M. Brate, Lakemont, N. Y., secretary.

A paper on "The Basic Principles of Two-Stroke-Cycle Design," by E. W. Roberts, Sandusky, Ohio, completed the program for the day. He brought out clearly the facts that to equal the four-stroke-cycle engine the ports must be ample, the base compression fairly high and the area through the carbureter at least twice as great as with a four-stroke-cycle engine of the same capacity.

On Saturday morning the matter of standardization was continued by Wm. H. Spire whose paper "Some Advantages of Standardization" showed the advantage and economy of buying standard parts over making special parts for the same purpose.

In "Pulley Specifications," S. M. Walker, of Chicago showed the absurdities of the present system of furnishing pulleys on engines and driven machinery both at the whim of the manufacturer. He proposed a standard belt speed be adopted to which all conform, in which the same farm engine might be used with a number of machines without the necessity of continually changing pulleys.

"What the Customer Wants in Lubrication," was cleverly presented by G. K. MacEdward, of Detroit, by excerpts from letters received from owners of engines made by members of the Association. The engine user desires protection from his own carelessness, the hired man's ignorance and the inherent defects of the usual oiling devices furnished with gas engines.

Oregon 45,000-Hp. Development

The completion of preliminary surveys for the development of 45,000 hp. within the next five years at Clear Lake, in the Cascade Mountains, 75 miles from Eugene, Ore., is announced by George S. Edmonton, hydraulic engineer of the Oregon Electric R.R., a Hill line. The construction of the first unit, of about 20,000 hp., is to begin in June, 1914, and plans contemplate getting the work far enough along to be able to work throughout the year. The first unit is expected to be in operation in two years.

Power from this point will be available over a radius of 100 miles, which means the territory from Portland almost to the California state line and well into Eastern Oregon.

The power site is midway between the Oregon Trunk line, the Hill railroad and the Deschutes River in the Willamette Valley. The site was formerly held by the Southern Pacific Ry. Co., which lost title by failure to develop within the time prescribed by the state. The Oregon Electric R.R. has already surveyed a transmission line down the Santiam Valley to Albany and is now running a survey down the McKenzie Valley.

The annual inspection trip of the department of electrical engineering, University of Illinois, was made Nov. 23-26, under the charge of Profs. E. B. Paine, Morgan Brooks, E. H. Waldo and J. M. Bryant. The party was divided into two sections, one visiting the Keokuk water-power plant, the other, the industries around Joliet, Ill. The sections met in Chicago, where the trip was concluded after trips to parts of the Commonwealth Edison system, the Hawthorne works of the Western Electric Co., and the Illinois Steel Works.

Smoke-Prevention Campaign

The Committee on Smoke Prevention of the American Railway Master Mechanics' Association has sent out the following notice to members:

On account of the increasing importance of this matter, your committee respectfully requests that each road assign to its best authority on the subject the duty of fully answering this circular.

1. Please give full progress report covering the application and the efficiency of the smoke-preventing air jets, blower, quick-opening blower valve and arch recommended in your committee's report to the convention of June, 1913. Blueprints desired with description; also gives costs.

(In this connection your committee urges your attention to and careful consideration of the report above referred to, particularly paragraphs 108 to 119, Recommendations.)

2. Have you installed on locomotives any special devices other than those recommended by your committee? If so, please send drawings, stating results obtained and costs.

3. Have you installed any special device for handling the smoke from roundhouses? If so, please send drawings, give results obtained, cost of plant and of its operation.

4. What influence on smoke prevention has the superheater on passenger, freight and switching locomotives? State type of superheater and give coal and smoke efficiencies as compared with saturated engines, as nearly as possible.

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Pension Fund for Employees

The Westinghouse Airbrake Co., Pittsburgh, Penn., has announced that, beginning Jan. 1 it would maintain a pension fund for employees and a relief system for their dependents. These benefactions are to be independent of the pension and relief to which they both contribute jointly.

The extension of the pension provisions is in the pensions to be granted widows, orphan children and other dependents of pensioners or other employees. These pensions are to the widow of a pensioner, during her widowhood, 80 per cent. of her decreased husband's pension, with 10 per cent. additional for each child under 16 years of age; the total not exceeding 100 per cent. of his pension. To the widow of an employee dying as a result of any accident arising out of or in the course of employment by the company, or of an employee dying while totally disabled as a result of such accident, a pension equal to 30 per cent. of her husband's wages, during her widowhood, with 10 per cent. additional for each child under the age of 16 years; the total not to exceed 60 per cent. of his wages. To the widow of an employee who is a member of the relief department of at least two years' standing at the time of his death, who shall die from causes other than occupation accident, a pension at the same rate. In addition, all employees of the relief department, in receipt of total disability pensions at the time of reaching the retirement age, go upon the pension roll for the same amount as if they were still in the company's service.

SOCIETY NOTES

The New England Association of Commercial Engineers held its noonday luncheon and meeting on Saturday, Dec. 13, at the Revere House, Boston, Mass., and it was well attended. An address was delivered by Frank Fessenden Crane, vice-president of the Atlantic Deeper Waterways Association.

At the Dec. 8 meeting of the Louisiana Engineering Society at Stanley Thomas Hall, Tulane University, Prof. R. S. Cocks, professor of botany, lectured upon "Southern Pines." The lecture was illustrated with lantern slides and microscopes, showing the structural differences in the varying grades of pine.

On Dec. 9, the annual oyster roast was held at Eagle Hall, Washington, D. C., by Columbia Council No. 22, Universal Craftsmen Council of Engineers. A large delegation attended from Baltimore. H. T. Morningstar, electrical engineer of the Washington Navy Yard, was chairman of the entertainment committee and toastmaster and Past National President Jones welcomed the guests and members. The enjoyable entertainment was furnished by both local and other talent.

PERSONALS

Joseph W. Peters has been appointed secretary of the board of managers of the Association of Engineering Societies with an office at 3817 Olive St., St. Louis, Mo. The "Journal" of the organization will be published from that office.

J. G. White returned Dec. 10 on the "Olympic" after six months absence in England and the Continent. Much of his time was spent in London at the home office of J. G. White & Co., Ltd. One of the important recent financial undertakings of that company is the formation of the International Light & Power Co. Ltd., a holding company owning securities in several electric light and tramway properties throughout South America.

OBITUARY

ROBERT E. BINNING

On Dec. 6, Robert E. Binning, a well known electrical engineer, died at his home in Plainfield, N. J., following an illness which began 10 months ago in Lima, Peru, where he was engaged in constructing a light and power plant. Mr. Binning is survived by his wife.

DAVID E. HAIRE

David E. Haire, a consulting refrigerating engineer, died at his home in Philadelphia, Penn., Dec. 4. For a number of years he was chief engineer of the American Ice Co. His early experience in engineering was gained in the steel mills of Ohio, Pennsylvania and West Virginia. He was a member of the Society of Refrigerating Engineers and of the Manufacturers Club of Philadelphia. Mr. Haire was 51 years old and leaves a widow, two daughters and two sons.

DANIEL M. BARTON

Daniel M. Barton, general purchasing agent of the General Electric Co., died at his home in Schenectady, Dec. 8, after a brief illness. Mr. Barton was one of the oldest employees of the company. He was born in Moriah, N. Y., in 1843, and moved with his parents to Ware, Mass. At 19 he enlisted with his brothers in the Tenth Massachusetts Regiment and fought at Fredericksburg and Gettysburg. In 1883 the Thomson-Houston Electric Co. was formed at Lynn, Mass. A brother, Silas A. Barton, was its active organizer, and three years later Daniel M. Barton became its production manager.

In 1893 Mr. Barton became assistant purchasing agent of the newly organized General Electric Co. A few years after the main office was established at Schenectady Mr. Barton was made general purchasing agent, which position he ably filled to the time of his death. He was well and favorably known in the business world, and his many friends and business associates will regret his death.

Mr. Barton leaves a widow, a daughter, Mrs. Robert E. Nivison, and three grandchildren, a brother, Silas A. Barton, of Waltham, Mass., and a sister, Vila Barton, of Northampton, Mass.

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Situation for License Inspector—The Civil Service Commission of Chicago, Ill., will hold an examination, Dec. 30, for a license inspector, class H, grade II, salary $1080 to $1440. Subjects of Examination: Special subject, penmanship, arithmetic, experience, report. Duties: To inspect steam plants to see that licensed engineers and water tenders are in charge; to report the conditions found to the department daily; to notify the department regarding engineers or water tenders who have not had their licenses properly transferred, or whose licenses are not uptodate; to act as witness in court against violators reported by him; to assist in office work when required.

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Waterproofing Leather—The following recipe for waterproofing leather is suggested by the "Mechanical World." Apply a mixture of four parts castor oil and one part raw india rubber, by weight. Heat the oil to 250 deg. F., then add the rubber, cut into small pieces. Gradually stir until the rubber is completely dissolved, and then pour into a vessel to cool. This waterproofing treatment leaves the leather soft and pliable.